
**STORY MILL ECOLOGICAL RESTORATION SELECTED
ALTERNATIVE CONCEPTUAL DESIGN REPORT
BOZEMAN, MONTANA**

Topical Report RSI-2383

prepared for

The Trust for Public Land
111 South Grand Ave
Bozeman, Montana 59715

October 2013



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ALTERNATIVE CONCEPTUAL DESIGN REPORT
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Topical Report RSI-2383

by

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EXECUTIVE SUMMARY

This report documents the approach used in developing a conceptual restoration design for the Story Mill project area located in northeast Bozeman, Montana. The Story Mill project area is comprised of three parcels: North Parcel, South Parcel, and the Triangle Parcel. Development of the conceptual restoration design for the Story Mill project area has followed a stakeholder driven process. This process began in late 2012 with The Trust for Public Land (TPL) inviting interested people to provide their opinions on the potential uses of the Story Mill site through an online survey. This was followed up by holding a community meeting at the Emerson Cultural Center on February 7, 2013. Following this community outreach by TPL, a group of stakeholders were assembled by TPL on April 15, 2013 to develop preliminary goals for the project.

RESPEC was hired at the end of June 2013 and continued this process of stakeholder outreach combined with the incorporation of technical information to develop a selected conceptual restoration design. While several components have occurred simultaneously, this process has generally followed a sequence of steps intended to deliver a restoration design that accomplishes stated goals/objectives, provides the services and amenities sought after by stakeholders and the Bozeman community, and that is cost effective and constructible within the constraints of the site. The series of steps used in this process and described in this report are:

Development of an ecological conceptual model→ Refine goals/Performance Metrics→ Collect, compile, and collate data→ Determine design elements for use in conceptual restoration alternatives→ Develop an evaluation matrix→ Complete conceptual restoration design→ Package design into three restoration alternatives→ Select one conceptual restoration alternative.

The overarching ecological goal for the project is:

In consideration of site constraints and other project goals, restore and protect on-site natural processes necessary for a functioning riparian and wetland system.

This goal is supported by the following five ecological objectives:

- E-1 Provide hydrologic connectivity between stream floodplain and wetlands to maximize riverine and wetlands habitat diversity.
- E-2 Remove river process constraints and non-natural features to the extent possible in the context of land ownership and access.
- E-3 Remove or modify drainage and excavated features that disrupt and diminish groundwater-dependent wetland extent and functioning to restore wetland functions to the extent site constraints allow.

- E-4 Demonstrate improved water quality (temperature, nutrients and sediment measures).
- E-5 Restore native plant diversity (upland, wetland and riparian communities) and minimize invasive plants.

The design process for restoration of wetland, riparian, and stream systems at the Story Mill site included the conceptual level design of three alternatives and, subsequently, comparison and selection of a preferred alternative. Three alternatives were developed that emphasized varying levels of ecological restoration actions and benefits. All alternatives were developed with the intention of meeting ecological project goal and objectives, as well as integrating with the public access and recreational use planning that is being conducted as a parallel design process. Brief descriptions of each alternative are provided below.

Alternative 1 - Ecological Restoration I

Alternative 1 would maximize restoration potential of wetland, riparian, and stream ecological processes within the physical and administrative constraints imposed on the site, while providing for public access and recreation and including key project elements for the enhancement of water quality in the East Gallatin River. Ecological function is maximized through the removal of all structures and most existing infrastructure on the property, restoring historic drainage conditions to enhance and expand existing wetlands, by providing connectivity between the channel and floodplain, removing floodplain and wetland fill, and removing riprap and trash from the channel, banks, floodplain and wetlands, and by implementing an aggressive planting program that re-naturalizes the area with native plants and removes non-native plants.

Alternative 2 - Ecological Restoration II,

Alternative 2 would achieve significant restoration of wetland, riparian and stream ecological processes while retaining select structures and emphasizing less intensive treatment options. Functionality would be improved through the removal of most existing structures on the property, restoring historic drainage conditions, providing improved connectivity between the channel and floodplain, removing floodplain and wetland fill, and removing riprap and trash from the channel, banks, floodplain and wetlands, and by implementing an aggressive planting program that re-naturalizes the area with native plants and removes non-native plants.

Alternative 3 – Passive Restoration

The Passive Restoration Alternative allows for passive restoration of the project site in which no active restoration activities are pursued other than removal of select structures, selective removal of trash from the channel and banks, and the long term management of invasive weeds. Under the Passive Restoration Alternative ecological processes may continue to function at reduced levels but may ultimately return to a greater level of function over a much longer timeframe (decades).

The Selected Alternative is a combination of Alternatives 1 and 2, which will maximize benefits to water quality, wetlands, and streams. As proposed, the Selected Alternative will more than double the amount of wetlands found on the site, adding roughly 8.1 acres of restored

wetlands to the roughly 7.5 acres of wetlands currently occurring on the three parcels that make up the project area. Vegetative diversity is improved through native plantings, restoration of site hydrology, and ongoing weed control efforts. It would also restore natural fluvial processes along 2,600 feet of the East Gallatin River through the removal of sidewalk rubble used as makeshift riprap, and the removal of old machinery and trash embedded in the channel and streambanks.

The Selected Alternative maintains the extent of the current pond on the South Parcel, but naturalizes the shoreline through grading and willow plantings. The potential for surface water quality improvements to Bozeman Creek is maximized through the creation of a new 1 acre backwater slough that will promote the deposition and uptake of nutrients found in creek waters. Surface water quality improvements are also proposed for the East Gallatin River on the Triangle Parcel and on the North Parcel. On these parcels the East Gallatin River is fairly incised and does not have as much access to its floodplain as is desirable. The solution proposed by the Selected Alternative is to create roughly 1.9 acres of new floodplain area, of which roughly 70% would be wetlands and 30% riparian forest. In addition, three new public access points to the East Gallatin River are proposed under the Selected Alternative.

Construction of the Selected Alternative would require the excavation of over 20,000 cubic yards of fill material. This material is planned to be repurposed and used as fill in a currently topographically depressed area of the North Parcel. This will minimize haul costs and assist in the construction of other park amenities, such as a parking lot. The projected construction cost for restoration actions under the Selected Alternative is \$574,500. As part of the proposed restoration actions, this includes the demolition and removal of the farm buildings found on the South Parcel and the storage garage on the Triangle Parcel, but does not include removal of the old slaughterhouse buildings or bridge found on the Triangle Parcel.

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1.0 INTRODUCTION

This report documents the approach used in developing a conceptual restoration design for the Story Mill project site located in northeast Bozeman, Montana, as shown in Figure 1-1. The Story Mill project site is located at approximately 45°41'55" N, 111°1'21"W in Gallatin County (Figure 1-1). It encompasses portions of SE ¼ of Section 31 and SW ¼ of Section 32 in Township 1S, Range 6E, as well as portions of NE ¼ of Section 6 and NW ¼ of Section 5 in Township 2S, Range 6E.

1.1 GENERAL APPROACH

The development of the conceptual restoration design for the Story Mill project area has followed a stakeholder driven process. This process began in late 2012 when The Trust for Public Land (TPL) invited interested people to provide their opinions on the potential uses of the Story Mill site through an online survey. Six hundred and ninety surveys were completed primarily by people living within Gallatin County, and 72 percent of which live in Bozeman. This survey was followed-up by holding a community meeting at the Emerson Cultural Center on February 7, 2013. Over 140 community members attended the meeting. Respondents to the survey and attendees of the meeting indicated that their top usage options included the following:

- To enhance trail connections along the Story Mill spur trail
- To restore wetlands to benefit water quality
- To create a new, natural area park for the city
- To create a nature sanctuary.

The top activities sought after in a new park were the use of new trails, opportunities to enjoy the river and water features, and opportunities for wildlife viewing.

After this community outreach, TPL assembled a group of stakeholders on April 15, 2013, to develop preliminary goals for the project. RESPEC was hired at the end of June 2013 and continued this process of stakeholder outreach combined with the incorporation of technical information to develop a selected conceptual restoration design. While several components have occurred simultaneously, this process has generally followed a sequence of steps intended to deliver a restoration design that accomplishes stated goals/objectives, provides the services and amenities sought after by stakeholders and the Bozeman community, and is cost effective and constructible within the constraints of the site. The series of steps used in this process and described in this report include the following:

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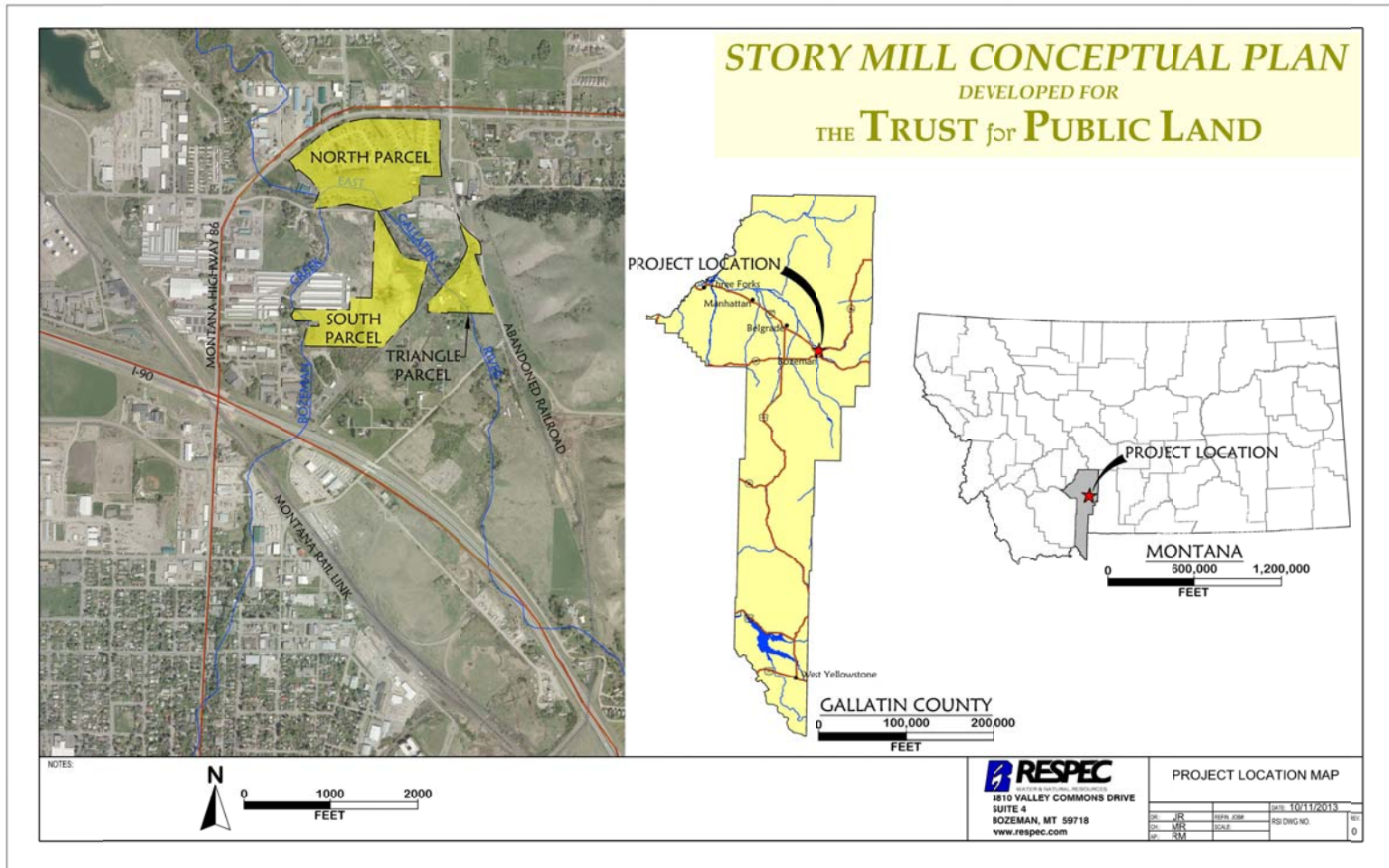


Figure 1-1. Story Mill Project Location Map.

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2.0 ECOLOGICAL CONCEPTUAL MODEL FOR RESTORATION

A conceptual model of the riparian/wetland ecosystem occurring within the Story Mill project area was developed. The goals of the conceptual model include the following:

- Synthesize information about key riparian ecosystem components and drivers found at the Story Mill project site
- Clearly illustrate the dominant relationships among ecosystem elements and historic, ongoing, and potential future stressors found at the site
- Facilitate communication about the key system components and processes found at the site and their relationships to ecological restoration
- Support management decisions about the site
- Identify data gaps for adaptive management
- Assist in identifying the specific prescription needed to restore site health and function.

The ecological processes within the project site occur at the regional, watershed, and local scales. The regional scale is defined as the Townsend Basin Level IV Ecoregion. The watershed scale is defined as the combined extent of the 12-digit hydrologic unit codes (HUCs) for Bozeman Creek and the four 12-digit HUCs that make up the East Gallatin River's watershed, and the downstream end of each HUC originates at their confluence. The total drainage area is 151.3 mi². The local scale, where any planned restoration activities would be implemented, are within the Story Mill properties owned by TPL and depicted in Figure 1-1.

The temporal scale used in the conceptual model extends from pre-European settlement to current day for existing conditions and current functionality of the site. To capture the potential effects of ecological restoration of the site, the temporal scale extends from today into the future for 25 years. Furthermore, several of the functions provided by Story Mill riparian areas are either limited to the growing season, or operate most effectively during the growing season. The growing season on the Story Mill site generally extends from April 20 through October 12 [Natural Resources Conservation Service, 2002].

While not comprehensive, the characteristics most relevant to any restoration actions taken on the site are captured in Table 2-1, and the most relevant relationships are shown in Figure 2-1.

Table 2-1. Site Characteristics Relevant to Restoration Actions

Site Characteristics
<p>CLIMATE (1981–2012)</p> <p><i>Growing Season</i> (28°F or greater, 50 percent of the time)</p> <ul style="list-style-type: none"> • May 5–October 1; 149 days <p><i>Temperature</i> (°F)</p> <ul style="list-style-type: none"> • Minimum = –32 (December 1983); Maximum = 100 (July 2002 and July 2007) <p><i>Precipitation</i> (inches)</p> <ul style="list-style-type: none"> • Minimum = 12.42 (2001); Maximum = 25.57 (1997) • Mean = 19.46; Median = 19.03 • Mean annual snowfall = 91.86 (primarily November–April)
<p>WATERSHED CHARACTERISTICS</p> <ul style="list-style-type: none"> • Igneous geology in upper Bozeman Creek’s Watershed and alluvial at lower elevations • Sedimentary geology in upper East Gallatin River’s Watershed and alluvial at lower elevations • Site occurs at an elevation of 4,725 feet above mean sea level • Urbanization • Agriculture • Nonpoint-source pollution has degraded water quality in both creeks—nitrogen, phosphorous, fecal coliforms, and sediment.
<p>SURFACE FLOW REGIME/ALLUVIAL AQUIFER</p> <ul style="list-style-type: none"> • Snowmelt hydrograph • Alluvial groundwater depths ranged from 0 to 57 inches below ground surface (bgs) in May 2013, generally tracked with the flow in the creeks, and dropped as the summer progressed. • The alluvial groundwater flows from south to north.
<p>FLOODPLAIN SOILS</p> <ul style="list-style-type: none"> • Site generally contains silty clay and clay loams in upper profile, sand, and gravels at deeper depths. Alluvial GW is mainly associated with the sand/gravel layer • The western portion of the site, closer to Bozeman Creek, is generally more clayey than other areas of the site.
<p>SITE GEOMORPHOLOGY</p> <ul style="list-style-type: none"> • Floodplain/valley bottom—depositional • Confluence of Bozeman Creek and the East Gallatin River • Site has been graded and drained for agriculture and a residence • Bozeman Creek and the East Gallatin River are both pool/riffle (C4) streams • Site generally drains from south to north.
<p>RIPARIAN VEGETATION</p> <ul style="list-style-type: none"> • Highly disturbed—majority of the site is grassland and dominated by introduced and invasive/noxious species • Palustrine emergent (PEM) wetlands in meadows and Palustrine scrub-shrub (PSS) wetlands along creeks. Patches of coyote willow occur on the southwest side of the site • An aspen grove occurs on the northeast side of the site.
<p>ANIMALS</p> <ul style="list-style-type: none"> • Migratory birds (e.g., Sandhill Cranes, waterfowl, and songbirds) • Whitetail deer • Beaver.

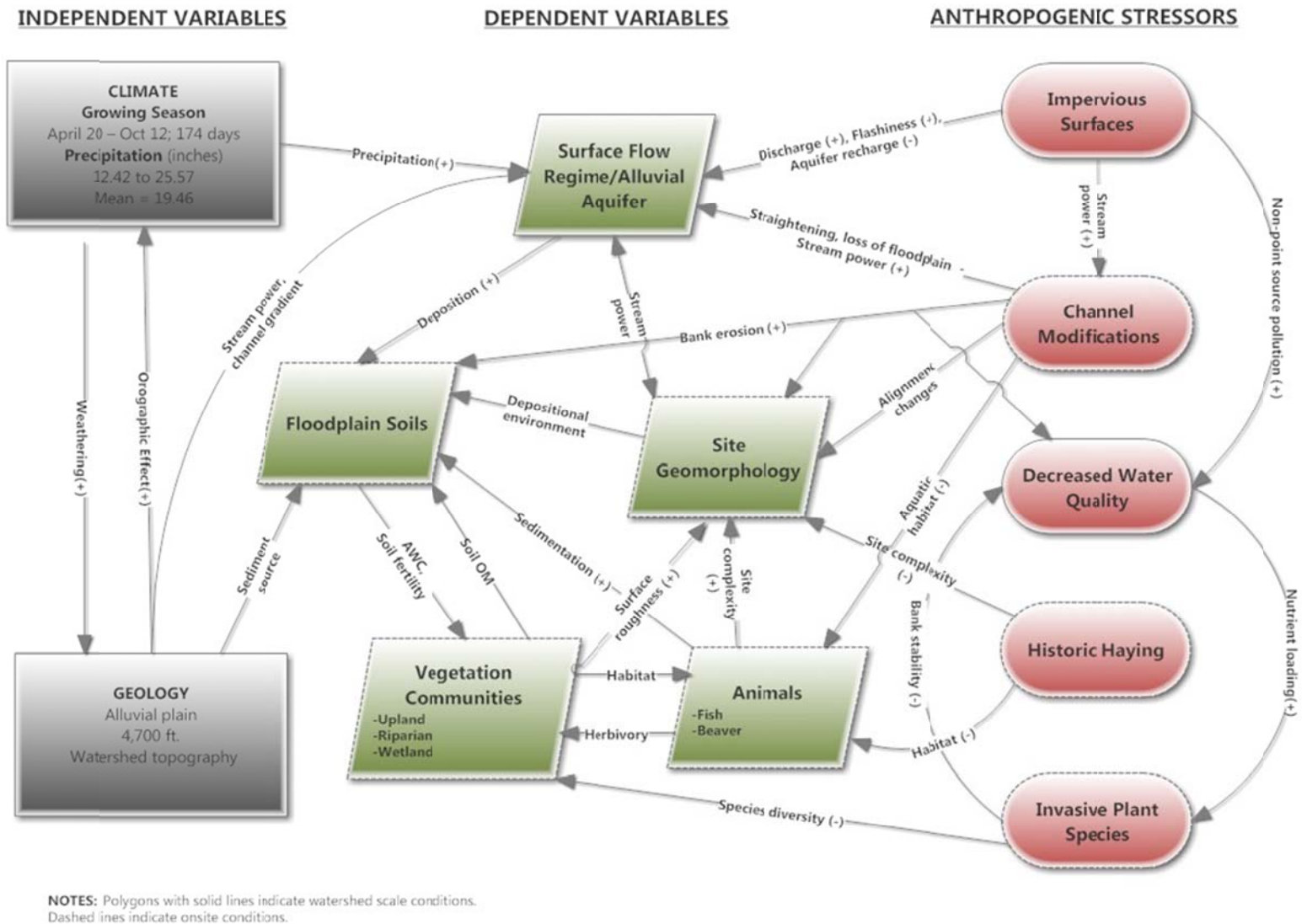


Figure 2-1. Ecological Conceptual Model for Wetland and Stream Restoration at the Story Mill Project Area.

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Site Observations Relevant to the Conceptual Model

1. Precipitation, or lack thereof, drives runoff in the system. Snowpack has historically been the primary source of runoff.
2. The characteristics of the watershed influence the timing, frequency, magnitude, and duration of runoff. Urbanization and agriculture are two of the main watershed characteristics that affect runoff and sedimentation in the project area by increasing the area of impervious surfaces. Impervious surfaces increase surface runoff, decrease time to runoff, and decrease infiltration and percolation into the shallow groundwater system and, thereby, potentially reduce the overall availability of groundwater, and/or the timing or duration that shallow groundwater is available on the site for wetland/riparian development. Agricultural modifications to channels, including channelization and bank protection, can increase stream power, reduce floodplain access, and promote bank/bed erosion. Surface water diversions, particularly for agricultural uses, can reduce late summer streamflows, which has consequences on water availability for plants and can increase water temperatures in the creeks.
3. Estimated 2-, 5-, 10-, and 25-year peak flows for Bozeman Creek in the project area are 235, 421, 577, and 807 cubic feet per second (cfs), respectively (RESPEC 2013).
4. Estimated 2, 5, 10, and 25 year peak flows for the East Gallatin River upstream of its confluence with Bozeman Creek are 387, 633, 828, and 1,120 cubic feet per second (cfs), respectively [RESPEC, 2013].
5. The flooding of Bozeman Creek and the East Gallatin River is typically asynchronous.
6. On site water availability and timing affects the types of riparian and wetland vegetation that will grow there. The increased disturbance levels of active floodplains caused by flashier runoff enables the establishment and persistence of invasive species in urban riparian corridors.
7. Erosion and depositional processes of Bozeman Creek and the East Gallatin River from natural and anthropogenic influences have shaped what remains of the site's original macro and microtopography, including the overall drainage of the site, the original drainage swales, and the higher terrace in the northeast corner of the site.
8. Topography influences seed deposition, establishment, and persistence. Site geomorphology directly affects the site's overall water regime, as well as the microsite water regime, which has direct consequences on plant composition and density. For example, cattails have a competitive advantage in areas that remain inundated for longer periods of time. A site with a diverse water regime generally leads to a higher diversity of niches available for plants and animals to inhabit, which has consequences on productivity, nutrient cycling, foodchain and trophic relationships, as well as the rates of biogeochemical processes occurring in the soil.

9. Ice production for food storage is presumably the reason the pond was originally excavated on the site.
10. Site clearing and hay production has had profound consequences to the vegetation found on the site, including the clearing of native riparian vegetation, the introduction and establishment of pasture grasses (including brome, orchard grass, timothy, reed canary grass, and Garrison creeping foxtail), and the introduction of noxious weeds (tansy, leafy spurge, and Canada thistle).
11. Agriculture and urbanization in the watershed continue to provide nutrient-laden runoff to the site via surface and groundwater flows.
12. The textures of on-site floodplain soils determines the baseline available water holding capacity and fertility of the site and, thereby, strongly influences which plant species will have a competitive advantage on the site.
13. Beaver have inhabited the site in the past and may be an important consideration in reestablishing woody plants on the site, particularly aspen and willows. Beaver management may become an important issue as the site is restored and becomes more naturalized.

3.0 REVISE GOALS AND DEVELOP PERFORMANCE CRITERIA

Several goals for ecological restoration of the site were developed by a stakeholder group in April 2013. While these original goals went toward identifying and formulating the desired outcomes for ecological restoration of the site, the RESPEC team felt that they needed additional refinement, that visualizing and identifying the desired future condition of the site and developing specific performance criteria would benefit the project and serve to establish the restoration philosophy used by the design team.

To this end, a meeting of the project stakeholders listed in Table 3-1 was held at TPL offices in Bozeman, Montana, on July 19, 2013. The purpose of the meeting was to discuss the ecological goals and performance criteria for restoration actions at the Story Mill project area. The meeting was facilitated by Mr. Rich McEldowney and Mr. Mike Rotar of RESPEC.

Table 3-1. Participants in the Ecological Goals and Performance Criteria Development Meeting, July 19, 2013

Name	Organization	Title	Telephone	Email
Rich McEldowney	RESPEC	Riparian Ecologist	406.599.2138	<i>rich.mceldowney@respec.com</i>
Tom Hinz	TPL	Consultant	406.580.1950	<i>ecolegacyconsulting@gmail.com</i>
Pat Byorth	Trout Unlimited/ Greater Gallatin Watershed Council	Vice Chair	406.548.4830	<i>pbyorth@tu.org</i>
Peter Skidmore	Consultant	Principal	406.600.8536	<i>peter@peterskidmore.com</i>
Maddy Pope	TPL	Project Manager	406.522.7450	<i>maddy.pope@tpl.org</i>
Michael Rotar	RESPEC	Water Resources Engineer	406.570.1035	<i>mike.rotar@respec.com</i>
Steve Carpenedo	Montana Department of Environmental Quality	Wetland Scientist	406.444.3527	<i>scarpenedo2@mt.gov</i>

Because the project area has been so disturbed over the years, photographs from several wetlands in the area were shared with the group to promote a discussion about the ecological potential of the site. These photographs included the following:

- Bridger Creek upstream of Drinking Horse Mountain
- Bridger Creek near the Bridger Creek Golf Course

- Bozeman Creek north of Goldenstein Road
- Groundwater dependent wetlands near Morningstar Elementary School
- East Gallatin Recreation Area (located just downstream from the project area).

These wetlands were then contrasted by specific slides of the East Gallatin River, Bozeman Creek, and the groundwater-supported wetlands found on the Story Mill project area that have been impacted by over 100 years of human habitation and agricultural modifications.

The following points were made by the stakeholders:

1. The preferred future condition of the site is for it to reach its ecological potential, as shown in Figure 3-1. Based on less-disturbed wetlands found in the area, the ecological potential of the site is a riparian forest and shrub complex with scrub/shrub and emergent wetlands in the lower/wetter areas. The dominant hydrology will be the creeks along the two stream corridors and alluvial groundwater in the central portion of the site.
2. The confluence of Bozeman Creek and the East Gallatin River makes the presence of wetlands both critical and priceless for the services they provide humans and wildlife. For this reason, wetland acreage on the site should be maximized within the constraints found on the site.
3. To the extent possible, restoration activities should be process based, and they should focus on removing human-imposed stressors on the system, so the site can heal itself. This will be particularly effective along the stream corridors. This type of approach will protract the restoration timeframe, but it is significantly less expensive and, ultimately, more sustainable and preferable.
4. The groundwater-dependent wetlands in the central portion of the site have been dramatically altered and will require a much more active approach to restoration.
5. Design alternatives should include additional restoration activities to be completed in the future.
6. The public should be informed about the healing process. While not expanded on during this meeting, thoughts included: (1) why restoration is important, (2) specific process-based remedies and habitat-specific actions being implemented for site restoration, (3) the timeframe for restoration, and (4) the constraints affecting site restoration.
7. Access to the creeks is a high priority for the public.

The results of the group effort and the ongoing development of the goals and performance criteria by Mr. McEldowney and Mr. Rotar are provided in Table 3-2. Note that several of the performance metrics will continue to be developed as the site continues to be studied and understood during the ongoing restoration design process.

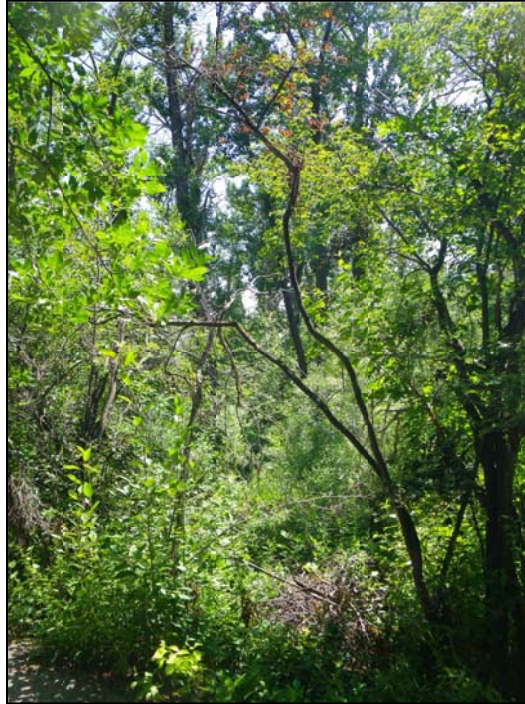


Figure 3-1. Projected Ecological Potential for the Story Mill Project Site.

3.1 VISION

Create a destination city park where people learn and recreate and where river and wetland resources are restored and protected for the Bozeman community.

3.2 OVERARCHING ECOLOGICAL GOAL

In consideration of site constraints and other project goals, restore and protect on-site natural processes necessary for a functioning riparian and wetland system.

Table 3-2. Ecological Objectives and Performance Metrics for the Story Mill Project Site (Page 1 of 2)

Ecological Objectives		Performance Metrics	Time Frame
E-1	Provide hydrologic connectivity between stream floodplain and wetlands to maximize riverine and wetlands habitat diversity.	<ol style="list-style-type: none"> 1. Flows > than the effective discharge have ready access to the floodplain in Bozeman Creek (BC) and East Gallatin River (EGR). 2. The post-restoration extent of the active floodplain is significantly greater (at least 50 percent) than the pre-restoration, active floodplain. The active floodplain is defined as the area subject to flooding during the 2-year flood event. 	At completion
			At completion
E-2	Remove river process constraints and non-natural features to the extent possible in the context of land ownership and access.	<ol style="list-style-type: none"> 1. 100 percent of streambanks and streambed on TPL property and adjacent property with granted restoration access are free of human-imposed constraints. 	At completion
E-3	Remove or modify drainage and excavated features that disrupt and diminish groundwater-dependent wetland extent and functioning to restore wetland functions to the extent site constraints allow.	<ol style="list-style-type: none"> 1. Natural drainage patterns are restored to the site. 2. Wetland hydrology is documented in 12 of the 15 groundwater wells (80 percent). Wetland hydrology is defined as depth to water within 12 inches of the soil surface for 14 consecutive days during the growing season (May 5 to Oct. 1). 3. Post-restoration extent of groundwater-dependent wetlands is significantly greater (at least 50 percent) than pre-restoration groundwater wetland extent. 4. Using the 2008 Montana Wetland Assessment Method, functional units found on the site are increased by 50 percent. 	At completion
			5 years
E-4	Demonstrate improved water quality (temperature, nutrients, and sediment measures).	<ol style="list-style-type: none"> 1. Reduction and moderation of diurnal and seasonal surface and groundwater temperature fluctuations within the project area during late summer (August 15–September 30) (<i>Modify as needed as monitoring information becomes available</i>). 2. Grid toss in pool tailouts shows a 25 percent reduction in fine sediment within, and directly below, the project area. 3. Develop metric for nutrients either using monitoring data (if possible), or based on TMDL. 	5–10 years

Table 3-2. Ecological Objectives and Performance Metrics for the Story Mill Project Site (Page 2 of 2)

Ecological Objectives		Performance Metrics	Time Frame
E-5	Restore native plant diversity (upland, wetland and riparian communities) and minimize invasive plants.	<ol style="list-style-type: none"> 1. Native plant canopy cover is ≥ 80 percent in each community type. 2. Ecological integrity is improving based on a Floristic Quality Assessment (FQA). The trend of the mean coefficient of conservatism (using all species) and the Floristic Quality Index (FQI) are increasing in all community types or are within 0.1 unit of a reference condition. 3. Tree and shrub species exhibit diverse ages, as exhibited by differing heights and the active recruitment and establishment of young trees and shrubs. 4. A long-term monitoring consortium is established to document change in vegetation communities and provide feedback for management decisions. 	10 years

4.0 DATA GATHERING

A list of the data collected for use in the restoration design is provided in Table 4-1.

Table 4-1. Summary List of Data Collected and Its Relevance to Restoration Design of the Story Mill Project Site (Page 1 of 3)

Data Collected	Relevance to Design
2013 Topographic Data (LiDAR data)	<ul style="list-style-type: none"> • Used in park planning and layout • Used in park management—access points, passive versus active recreation areas, and safety planning • Used to identify where earth moving modifications are needed to create different features • Used to quantify earth moving requirements, which are then used in developing construction cost estimates • Used in conjunction with site-specific channel survey and cross-section data for hydraulic modeling
Building Structural Report	<ul style="list-style-type: none"> • Provides information needed for cost estimates for demolition or for ongoing maintenance costs
Climate	<ul style="list-style-type: none"> • Helps to establish restoration potential • Used in water budgeting • Used in construction planning
Existing Infrastructure and Utility Locations	<ul style="list-style-type: none"> • Typically used as a design constraint for features to avoid disturbing or to remove. • Can be used to identify infrastructure that will be removed or re-purposed • Used in park planning
Floodplain mapping	<ul style="list-style-type: none"> • Provides an understanding of estimated water surface elevations under flood conditions and the extent to which the site could be impacted during a 1%-annual-chance flood event
Flow modeling/ simulations (HEC-RAS)	<ul style="list-style-type: none"> • An important tool for visualizing and evaluating design alternatives • Simulate spatial extent and depth of water within the channel areas and across the floodplain to understand how different elements in the proposed alternatives affect water flow and distribution within the project area • Modeling can help to identify potential problem areas for management and/or design consideration
Historic and Existing Wetland Mapping	<ul style="list-style-type: none"> • Provides context for the project • Helps to show how the site has changed over time—site trajectory, geomorphic analysis, and vegetation analysis • Helps to establish restoration potential • Can provide insight for design elements
Historic-to-Recent Aerial Photographs	<ul style="list-style-type: none"> • Place site in context with its surroundings • Establish level of departure from undisturbed or less-disturbed conditions • Helps to establish a restoration potential for the site • Can help to identify past disturbances that may not be immediately obvious today

Table 4-1. Summary List of Data Collected and Its Relevance to Restoration Design of the Story Mill Project Site (Page 2 of 3)

Data Collected	Relevance to Design
On-Site Groundwater Elevations	<ul style="list-style-type: none"> • Alluvial groundwater is an important driver in wetland establishment; in general, knowledge of the physical and chemical characteristics of the soils found on site is important to understanding the site's restoration potential • Used in water budgeting (infiltration and saturated hydraulic conductivities) • Useful to help identify which vegetation communities can be established where • In conjunction with surface water information, groundwater information improves understanding of how the site functions at different times of the year, and how that affects the spatial extent of wetlands and riparian areas found on site • Used in design as a site constraint to limit extent of flooding, to understand the functional limits of what is possible • Construction planning
Period of Record Stream Flow Data	<ul style="list-style-type: none"> • Identify timing and characteristic discharge in each creek, such as bankfull discharge, peak and, low-flow discharges • Informs restoration goals and success criteria and can be used as a quantitative metric in specific success criteria • Important for specific design elements related to bank repair and reactivation of secondary channels on the East Gallatin River • Evaluation of the potential to include stormwater-quality elements into the design for Bozeman Creek • Assists with identification of the type of bioengineering methods to be used where • Depending on design, they are often useful for identifying revegetation zones • Important to understanding alluvial groundwater levels observed on the site • Can help with on site management decisions (e.g., risk assessments and placement and type of infrastructure) • Construction-related issues, such as access • Needed for permitting
Phase 1 Environmental Site Assessment	<ul style="list-style-type: none"> • Identifies if there are any hazardous materials known to occur on the site that may need special remediation or consideration
Photographic Inventory	<ul style="list-style-type: none"> • Provides a visual record of baseline conditions for a comparison to post-construction conditions
Soils	<ul style="list-style-type: none"> • The physical and chemical characteristics of the soils found on site are important to understanding the site's restoration potential • Used in water budgeting (infiltration and saturated hydraulic conductivities) • Useful to help identify which vegetation communities can be established where • Used to identify if soil amendments (e.g., compost) are needed or not to promote vegetation establishment and growth
Stream Channel and Pond Survey Data	<ul style="list-style-type: none"> • Longitudinal profiles assist in understanding how the current system operates and what is needed to meet desired future condition (e.g., pool-glide-riffle-run relationships) • Channel cross-sections provide a better understanding of how the site performs relative to its discharge • Data is used in design to show what needs to be completed where, such as bank treatments • Bathymetry data from pond will be used to determine earth moving requirements, and revegetation components

Table 4-1. Summary List of Data Collected and Its Relevance to Restoration Design of the Story Mill Project Site (Page 3 of 3)

Data Collected	Relevance to Design
Stream Channel Pebble Counts	<ul style="list-style-type: none"> •Provides information on stream power and shear stress needed in design for channel sediment competency calculations (e.g., aggradation/degradation predictions) •Provides information on sediment supply entering the stream upstream of the project area and allows the design to accommodate those inputs •Data can be used to help identify sediment supply problems and habitat impairment issues
Vegetation Mapping	<ul style="list-style-type: none"> •Noxious weed treatments •Recreation planning—maintenance requirements and activity centers •Revegetation planning, such as layout and composition of native species and communities found on site, prioritization of areas to keep natural, and other areas to convert •Wetland layout •Potential to salvage wetland soils and/or vegetation •Identify sources of plant material for revegetation (e.g., willow cuttings and sedge mats)
Water-Quality Information	<ul style="list-style-type: none"> •Provides context for the project •Can inform decision making on restoration goals and success criteria related to water quality •Can help identify specific design elements needed to improve water quality (e.g., retention times)
Water Rights Review	<ul style="list-style-type: none"> •Consultation with the MT Department of Natural Resources Conservation (DNRC) on constraints posed by water availability for the project and different design elements that would not be acceptable for use in the project
Watershed Groundwater Information	<ul style="list-style-type: none"> •Provides context for the project •Use regional groundwater reports for the lower Gallatin watershed to better understand watershed-scale groundwater movement and seasonality
Watershed Report for the Lower Gallatin	<ul style="list-style-type: none"> •Provides context for the project
Wetland Functional Assessments	<ul style="list-style-type: none"> •Identifies baseline conditions of different wetland functions operating on the site •Useful as a success criteria—functional lift •Helps identify specific design elements or types of design elements that could be incorporated into the design to enhance or restore specific functionality •Helps to identify stressors/constraints affecting the site that can temper restoration expectations

5.0 ALTERNATIVE DEVELOPMENT

The design process for restoring wetland, riparian, and stream systems at the Story Mill site included the conceptual level design of three alternatives and, subsequently, comparing and selecting a preferred alternative. Developing the three alternatives was conducted with the understanding that ultimately the selected alternative may include a combination of restoration elements from more than one of the alternatives in order to strike a balance between budgetary constraints and conservation and recreation goals.

Alternative development was accomplished by meeting with TPL on August 5, 2013, to develop restoration approaches or themes and discuss specific constraints affecting ecological restoration of the site, and the specific design elements that could be used to address site constraints and achieve project goals.

Through this meeting and a subsequent follow-up with meeting participants, three alternatives were developed that emphasized varying levels of ecological restoration actions and benefits. The descriptions of each alternative are provided below and the list of specific design elements assigned to each alternative is provided in Table 5-1. All alternatives were developed with the intention of meeting ecological project goals and integrating with the public access and recreational use planning that is being conducted as a parallel design process. The extent of removing existing structures and infrastructure, that currently constrain ecological processes, is a dominant variable used to differentiate among the three alternatives. A “minimal action” alternative was included to provide a comparison of anticipated outcomes and associated costs of the two restoration alternatives to a minimal level of site stewardship.

5.1 ALTERNATIVE 1—ECOLOGICAL RESTORATION I

Alternative 1 would maximize the restoration potential of wetland, riparian, and stream ecological processes within the physical and administrative constraints imposed on the site, while providing for public access and recreation and including key project elements for the enhancement of water quality in the East Gallatin River. Restoring ecological processes would maximize wetland, riparian, and stream functionality for water-quality improvement, flood flow attenuation, wildlife and fish habitat, short- and long-term surface water storage, foodchain support, groundwater discharge/recharge, and the site’s potential for recreation and education. Ecological function is maximized by removing all structures and most existing infrastructure on the property; restoring historic drainage conditions to enhance and expand existing wetlands; providing connectivity between the channel and floodplain; removing floodplain and wetland fill; removing riprap and trash from the channel, banks, floodplain and wetlands; and implementing an aggressive planting program that re-naturalizes the area with native plants and removes non-native plants.

Table 5-1. Restoration Design Elements by Alternative For the Story Mill Project

Restoration Design Elements	Alternative		
	1	2	3
North Parcel			
Expand East Gallatin River floodplain, excavate fill, and expand potential for water-quality improvement	+++	++	—
Pedestrian river access	✓	✓	✓
Restore wetland and vegetative diversity	+++	++	+
River corridor cleanup—remove riprap and trash	✓	✓	—
South Parcel			
Remove farm buildings	✓	✓	✓
Keep driveway up to bend for trail	✓	✓	✓
Reconfigure pond/ditch	✓	✓	—
Excavate Bridger Creek floodplain, and expand potential for water-quality improvement	✓	—	—
Restore wetland and vegetative diversity	+++	++	+
Pedestrian river access	—	—	—
Pedestrian wetland observation trails	✓	✓	—
Multiuse connector trail	✓	✓	✓
River corridor cleanup—remove riprap and trash	✓	—	—
Triangle Parcel			
Remove garage	✓	✓	✓
Remove slaughterhouse buildings	✓	—	—
Remove bridge	✓	—	—
Pedestrian river access (convert driveway)	✓	✓	—
Truncate driveway at house	✓	✓	—
Expand East Gallatin River floodplain, excavate fill, and expand potential for water-quality improvement	+++	++	—
Restore wetland and vegetative diversity	+++	++	+
River corridor cleanup—remove riprap and trash	+++	++	—

✓ = included in alternative
 — = not included in alternative
 +++ = highest level of effort
 ++ = moderate level of effort
 + = lowest level of effort.

5.2 ALTERNATIVE 2—ECOLOGICAL RESTORATION II

Alternative 2 would achieve significant restoration of wetland, riparian, and stream ecological processes while retaining select structures and emphasizing less intensive treatment options. Restoring ecological processes would restore significant wetland and riparian functionality for water-quality improvement, flood flow attenuation, wildlife and fish habitat, short- and long-term surface water storage, foodchain support, groundwater discharge/recharge, and the site's potential for recreation and education. Functionality would be improved by removing most existing structures on the property; restoring historic drainage conditions; providing improved connectivity between the channel and floodplain; removing floodplain and wetland fill; removing riprap and trash from the channel, banks, floodplain and wetlands; and implementing an aggressive planting program that re-naturalizes the area with native plants and removes non-native plants.

5.3 ALTERNATIVE 3—PASSIVE RESTORATION

Alternative 3 allows for the passive restoration of the project site in which no active restoration activities are pursued other than removing select structures, and trash from the channel and banks as well as the long-term management of invasive weeds. Under the Passive Restoration Alternative, ecological processes may continue to function at reduced levels but may ultimately return to a greater level of function over a much longer time frame (decades).

6.0 EVALUATION MATRIX

Eighteen criteria were developed to evaluate each of the alternatives in an objective manner. When possible, they were made quantifiable. These evaluation criteria are discussed in Table 6-1 and Table 6-2 lists how each relates to the five ecological restoration objectives. Six of the criteria are general project considerations, five are related to financial concerns, six relate to the first objective (E-1), five relate to each of the second and third objectives (E-2 and E-3), seven relate to the fourth objective (E-4), and six relate to the fifth objective of the project (E-5).

Table 6-1. Explanation of Evaluation Criteria (Page 1 of 2)

Evaluation Criteria		Comments
1.	Probability of meeting ecological objectives (low, moderate, high)	Provides a general, overall idea of how each of the alternatives meet ecological objectives. More specific quantitative measures are provided in other criteria.
2.	Relative complexity of project; difficulty of implementation (low, moderate, high)	Provides a qualitative measure of risk of project delays and budget overruns. It is based on the relative complexity involved in implementing an alternative. The underlying logic is that the more complex the alternative, the more opportunities there are for things to go wrong.
3.	Relative level of uncertainty in project outcome (low, moderate, high)	Based on design team's observations and data gathered, analyzed, and modeled to date, this measure provides a qualitative assessment of the relative level of uncertainty the project team has in the overall predicted outcomes for each alternative.
4.	Acres of riverine wetland habitat restored at project completion	Based on predicted local hydrology. Riverine wetlands depend on bank overflow for their hydrology and provide different functions than slope wetlands. Restoring riverine wetlands depends on removing fill material from floodplains. The area of restored riverine wetlands is based on the predicted 2-year flood event.
5.	Acres of slope wetland habitat restored at project completion	Based on predicted local hydrology on the South Parcel and restoration actions in the southwest corner of the Triangle Parcel. Slope wetlands depend on groundwater for their hydrology and function differently than riverine wetlands. Restoration efforts for slope wetlands include the modification/re-grading of the man-made pond and drainage features on the South Parcel.
6.	Perimeter to area ratio of largest, contiguous wetland polygon (feet:sq. ft)	This criterion provides a measure of interior core wetland habitat—the lower the number the more interior core habitat. Given the existing wetland configuration, the amount of edge habitat on the existing polygons would be expected to decrease (become less complex) and the interior core wetland habitat to increase.
7.	Montana wetland assessment functional units	Integrates wetland acreage and wetland functionality. Functional units are based on predicted function scores and wetland acreages. The four assessment areas (AAs) used were developed and functional units summed together by alternative. The AAs used were slope wetlands on South Parcel, Bozeman Creek from I-90 to Osterman's storage units, East Gallatin River from L Street to Mill Ditch, and East Gallatin River-Mill Ditch to Bridger Drive. The largest increase in functional units would come from restoring slope wetlands on the South Parcel.
8.	Extent of ponded open water (acres)	This is a feature that has been identified by the community as a desirable amenity. Seasonal and perennial open water are considered equally at their maximum pool elevation.
9.	Total acres of temporary disturbance	Risk of invasive/noxious plant species spreading.
10.	Acres of restored riparian habitat within 5 years of project completion	Based primarily on active planting efforts on site.

Table 6-2. Explanation of Evaluation Criteria (Page 2 of 2)

Evaluation Criteria		Comments
11.	Increase in the length of streambank where creek is allowed to freely access its active floodplain (feet) ^(a)	Measure of hydrologic connectivity between channel and floodplain based on the predicted 2 year flood event.
12.	Increase in the extent of floodplain area (acres)	Measure of hydrologic connectivity of channel and floodplain and functionality of floodplain. Complements Criterion #11. Considers total fill removal area in the floodplain of the East Gallatin River (i.e., 10-year flood event).
13.	Length of East Gallatin River streambanks and streambed on TPL property that are free of direct human-imposed constraints (feet)	Measure of process constraints. This metric only considers direct constraints, not indirect constraints. For example, at a particular flow level, a bridge exerts a constraint on a channel for a few hundred feet up and downstream of its location. This metric only considers the direct impact of the physical length of bridge that occurs on either streambank that is constricting the channel. For this reason, it will underrepresent the actual adverse effect the bridge has on the creek at higher flow levels. In addition, the effect of the bridge on flow and the consequences to creek channel and banks are acknowledged to change at different flows.
14.	Estimated cubic yards of excavation	Metric useful for planning and costs. Excess clean soil is assumed to be disposed of in the northwestern portion of the North Parcel, which is currently lower in elevation compared to the eastern side.
15.	Estimated construction cost (excluding demolition)	Financial metric. Estimate is commensurate with the conceptual level of design. See Appendix B for information on assumptions.
16.	Estimated demolition cost	Provides detail on financial aspect of project. Developed from RS means estimates. See Appendix B for information on assumptions.
17.	Estimated cost of building maintenance	Provides detail on financial aspect of project. This calculation is primarily to show that there is an ongoing cost associated with keeping the buildings, but the actual cost for maintenance will likely differ substantially from the numbers used here for comparison. Building maintenance is based on \$1000/building/year for 10 years. The chicken coop on the South Parcel is not counted.
18.	Number of public access points to creek	This is a feature that has been identified by the community as a desirable amenity. Alternatives 1 and 2 would have two access points on the North Parcel, no access points on the South Parcel, and 1 access point on the Triangle Parcel.

(a) The active floodplain is defined as the area subject to flooding during the 2-year flood event.

Table 6-3. Evaluation Criteria and Their Relevance to the Ecological Objectives of the Story Mill Project (Page 1 of 2)

Evaluation Criteria		General Project Consideration	Financial Consideration	Ecological Objectives				
				E-1 Hydrologic Connectivity	E-2 Remove River Process Constraints	E-3 Remove/Modify Drainage	E-4 Demonstrate Improved Water Quality	E-5 Restore Native Plant Diversity
1.	Probability of meeting ecological objectives (low, moderate, high)	X						
2.	Relative complexity of project; difficulty of implementation (low, moderate, high)	X						
3.	Relative level of uncertainty in project outcome (low, moderate, high)	X						
4.	Acres of riverine wetland habitat restored at project completion			X			X	X
5.	Acres of slope wetland habitat restored at project completion					X	X	X
6.	Perimeter to area ratio of largest, contiguous wetland polygon (square feet)					X	X	X
7.	Montana wetland assessment functional units			X	X	X	X	X
8.	Extent of ponded open water (acres)					X	X	
9.	Total acres of temporary disturbance	X	X					X
10.	Acres of restored riparian habitat within 5 years of project completion			X	X	X	X	X

Table 6-2. Evalutaion Criteria and Their Relevance to the Ecological Objectives of the Story Mill Project (Page 2 of 2)

Evaluation Criteria		General Project Consideration	Financial Consideration	Ecological Objectives				
				E-1 Hydrologic Connectivity	E-2 Remove River Process Constraints	E-3 Remove/Modify Drainage	E-4 Demonstrate Improved Water Quality	E-5 Restore Native Plant Diversity
11.	Increase in the length of creek allowed to freely access its active floodplain (feet) ^(a)			X	X		X	
12.	Increase in the extent 10 years of floodplain area (acres)			X	X			
13.	Percent of streambanks and streambed on TPL property that are free of human-imposed constraints			X	X			
14.	Estimated cubic yards of excavation	X	X					
15.	Estimated construction cost (excluding demolition)		X					
16.	Estimated demolition cost (2013 dollars)		X					
17.	Estimated cost of building maintenance		X					
18.	Number of access points to creek	X						
Total		6	5	6	5	5	7	6

(a) The active floodplain is defined as the area subject to flooding during the 2-year flood event.

7.0 RESTORATION DESIGN

This section describes the design process used, assumptions made, and the design constraints considered in developing the three conceptual restoration alternatives. The three restoration alternatives are presented in Section 8.0 of this report.

7.1 DESIGN PROCESS

The specific methods used in developing the three conceptual alternatives included the following:

1. Precipitation analysis
2. Surface water analyses of Bozeman Creek and the East Gallatin River
3. Alluvial groundwater analysis of the South Parcel
4. Water rights analysis
5. Vegetation analysis
6. Projections for wetland establishment
7. Cost estimating.

7.1.1 Precipitation Analysis

Climate data from the Western Regional Climate Center (WRCC) were evaluated for the Story Mill project site. The closest active, most relevant weather station to the project site is located at Montana State University (National Climate Data Center COOP Station 241044). Precipitation averages 19.46 inches per year. Figure 7-1 shows that May and June are the wettest months of the year and, thus, the time of year when wetlands in the project area are most likely to be their wettest [Western Regional Climate Center, 2013].

Table 7-1 provides some context for precipitation during the data gathering activities in 2012 and 2013. Average precipitation between April and June typically totals 8.55 inches and 11.68 inches between April and August. Precipitation in April 2012 was above average but significantly below average in May and June 2012. From April through June 2012, precipitation was 7.24 inches or approximately 1.31 inches below normal. In 2013, precipitation in May, and to a lesser extent in June, was above average; though precipitation for April through June was 8.7 inches or approximately 0.15 inch above average [Western Regional Climate Center, 2013]. If the entire period from April through August is considered, then both 2012 and 2013 had below average precipitation levels (Table 7-1). Evaporation is high during these months and totals roughly 15 inches between April 1 and June 30 and 30.5 inches from April through August (Table 7-1). The high level of evaporation underscores the semi-arid

conditions of the site and the need for additional surface water or groundwater to support wetlands in the area.

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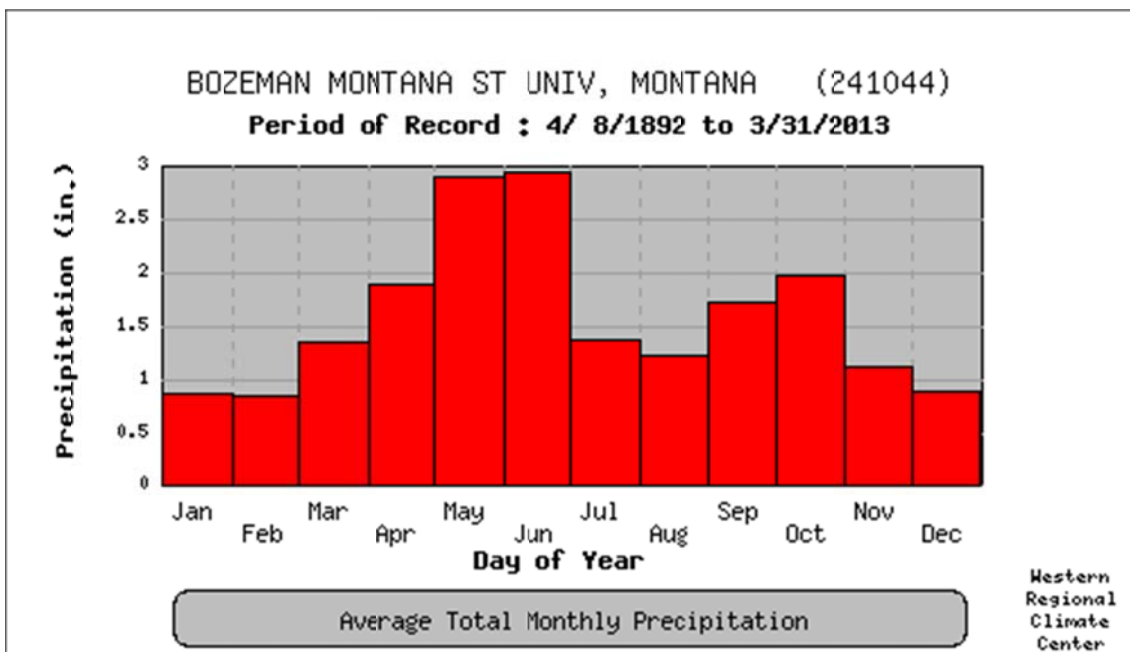


Figure 7-1. Precipitation Graph for the Story Mill Project Area.

Table 7-1. Precipitation Values (Inches) For the Story Mill Project Area [Western Regional Climate Center, 2013]

	April	May	June	July	August	Total
Mean	2.39	3.09	3.35	1.49	1.37	11.68
Minimum	0.39	0.73	0.56	0.10	0.04	1.82
Maximum	4.67	6.99	5.49	4.95	3.43	25.53
2012	3.3	2.4	1.54	1.13	0.58	8.95
2013	0.94	4.31	3.45	0.71	0.74	10.15
Average Pan Evaporation	3.34	5.58	6.03	8.34	7.17	30.46

7.1.2 Surface Water Analysis

Hydrologic and hydraulic analyses of Bozeman Creek and the East Gallatin River was performed using gage data from U.S. Geological Survey (USGS) Gage 060480000 and guidance provided by the USGS report, *Methods for Estimating Flood Frequency in Montana Based on*

Data through Water Year 1998 [Parrett and Johnson, 2004]. This gage is no longer in service but was located just downstream of the East Gallatin River/Bozeman Creek confluence and recorded 23 annual peak flow events primarily between 1940 and 1961. A peak flow event from 1981 is also included.

A steady-state peak flow analysis was completed for both reaches using the standard-step backwater model HEC-RAS version 4.1 [U.S. Army Corps of Engineers, 2010]. Recently acquired, high-resolution LiDAR topographic data [Photo Science, 2013] was the basis for creating the existing conditions geometry for both reaches; this data was supplemented by field survey data that included channel cross-sections and longitudinal profiles of each creek. A much more detailed description of the hydrologic and hydraulic analyses is provided in Appendix A.

Figures 7-2 and 7-3 provide some context for water years 2012 and 2013. This is relevant to restoration design because wetland delineation was completed in 2012, and alluvial groundwater was monitored on the sites in 2013. As shown in Figure 7-2, discharge in the 2012 water year (October 1, 2011, to September 30, 2012) was above average through the middle of May and slightly above average for the rest of the water year. Figure 7-3 shows that discharge during the 2013 water year (October 1, 2012, to September 30, 2013) has been, at or slightly below, average. This information on cumulative water flows for the 2012 and 2013 water years provides important context on how to interpret the wetland delineation completed in July 2012 and the alluvial groundwater data collected in 2013. It indicates that they generally bracket the high (2012) and low (2013) water flows for an average year.

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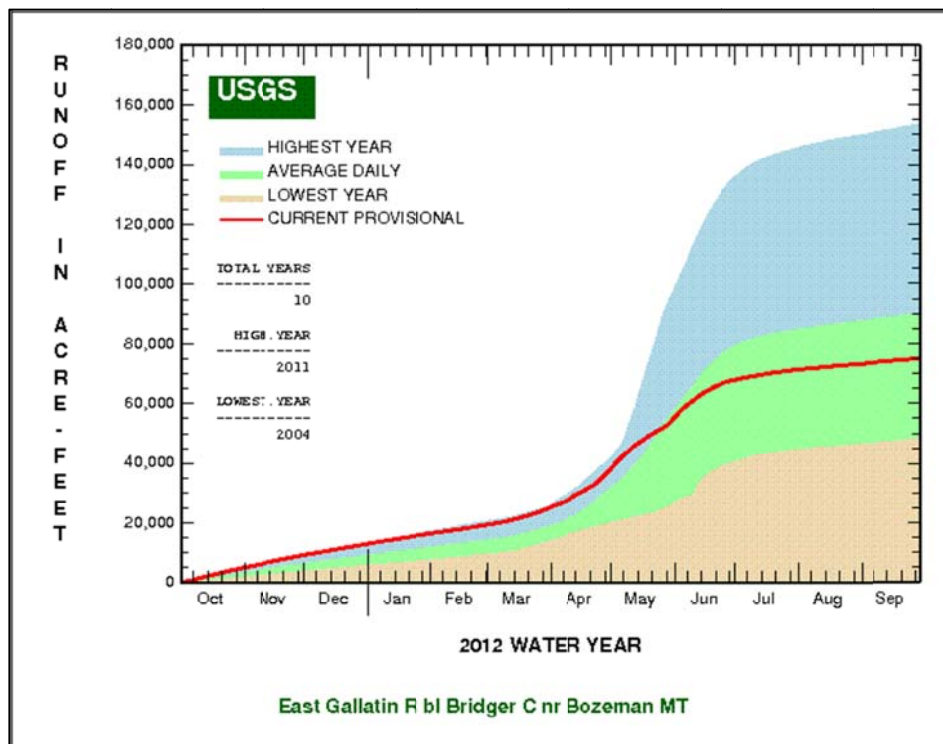


Figure 7-2. Cumulative Water Flow for the East Gallatin River—Water Year 2012.

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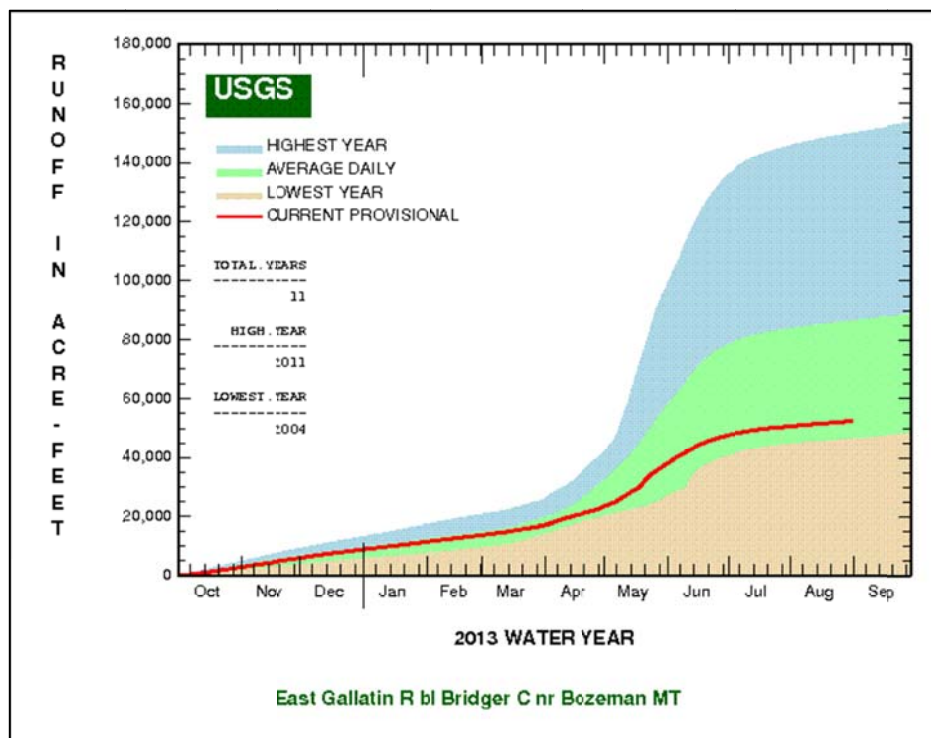


Figure 7-3. Cumulative Water Flow for the East Gallatin River—Water Year 2013.

Using the gage transfer method described in Parrett and Johnson [2004] and gage data from the active gage on the East Gallatin River below Bridger Creek (USGS gage 06048700), the predicted flow events are listed in Table 7-2.

Table 7-2. Predicted Flow Events For the East Gallatin River

Flood Event	Discharge (cfs)
2-year	796
5-year	1,190
10-year	1,487
25-year	1,914

Peak flows, as recorded on the East Gallatin River (gage 06048700) in 2012 and 2013, were 461 cfs on May 2, 2012, and 558 cfs on May 20, 2013. Both of these flows are substantially below the predicted 2-year flood event. It is interesting to note that the East Gallatin River

flows of late May 2008 (1,900 cfs) and late May 2011 (1,450 cfs) roughly correspond to the predicted 25-year and 10-year flood events, respectively.

7.1.3 Alluvial Groundwater Analysis

Alluvial groundwater data were collected at 15 wells located around the South Parcel, as shown in Figure 7-4, during the 2013 growing season. This data was evaluated in terms of the depth to water below the ground surface as well as its absolute elevation above mean sea level, which are illustrated in Figure 7-5. The evaluation of the depth below ground surface provides information relevant to wetland establishment and projected future establishment. An evaluation of groundwater elevations above mean sea level (e.g., 4,729 feet) provides information about the direction and gradient of groundwater flow.

An analysis of the groundwater levels, when compared to the discharge of the East Gallatin River (Figure 7-5), shows that the groundwater found on the South Parcel fluctuates seasonally and episodically. Alluvial groundwater levels on the South Parcel are highest during the spring and decrease over the summer. In 2013, the highest groundwater levels were observed on May 19 and corresponded to the highest recorded discharge levels for the East Gallatin River, which occurred on May 20. Groundwater levels generally decreased over the rest of the summer, closely matching flows in the creeks, and were the lowest at the end of August. In mid-September, as irrigation season came to an end, both flows in the creeks and the groundwater elevations increased on the South Parcel. Groundwater was also observed to increase in response to rainfall events and corresponding increases in discharge in the East Gallatin River on June 14 and June 29.

Alluvial groundwater levels were also related to actual surface elevations and then analyzed using a triangulated irregular network (TIN) in a geographic information system (GIS). This analysis showed that groundwater is generally flowing from south to north across the South Parcel.

Conclusions from this analysis of groundwater relevant to restoration design on the South Parcel include the following:

- The hydrology of wetlands found on the interior portion of the South Parcel is directly linked to discharge in Bozeman Creek and the East Gallatin River.
- Shallow, alluvial groundwater flows from south to north across the project area.
- Wetlands on the South Parcel will be seasonally wettest between mid-May and mid-June; therefore, the design elevation for groundwater should be based on a high groundwater elevation. Elevations of groundwater measured on May 19, 2013, were used in the restoration design.



Figure 7-4. Groundwater Well Locations on the South Parcel of the Story Mill Project Area.

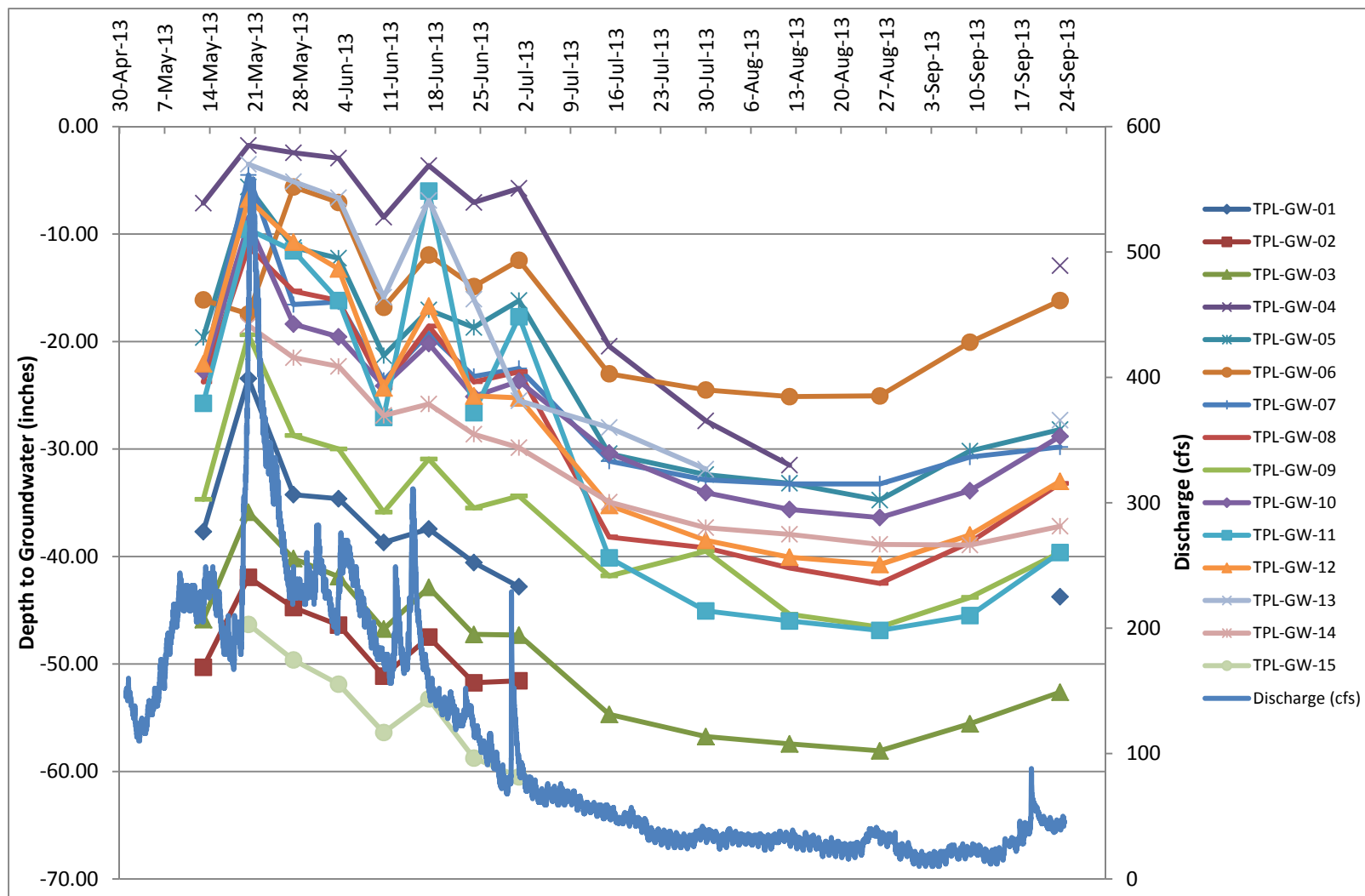


Figure 7-5. Depth to Groundwater and Discharge of the East Gallatin River (below Bridger Creek) at the Story Mill Project Site (note that groundwater levels were not monitored continuously, and the lines between groundwater sampling dates are included to show trends in groundwater; actual groundwater levels likely fluctuated more frequently and more drastically than depicted).

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- Precipitation levels were high in May 2013, but the discharge of the creeks did not reach the predicted 2-year flood event, which suggests that use of the May 19, 2013, groundwater levels is both reasonable and conservative.

7.1.4 Water Rights Analysis

A Mr. Steve Cook with the Montana Department of Natural Resources Conservation staff in Bozeman was consulted with regard to water rights for the project area. No surface water rights or points of diversion are associated with any of the parcels in the Story Mill project area. There is one groundwater right from 1983 for the South Parcel (Water Right ID: 41H 49720 00). It allows for a flow rate of 16 gallons per minute, or 5.41 acre-feet per year, and the irrigation of 0.5 acre of land. According to their records there are three wells on the North Parcel, but none of them have water rights associated with them. There is no water right associated with the pond. The drainage ditch on the property is not a designated ditch and so appears to be a true drainage ditch that is not used for irrigation. For this reason, if the ditch is filled no water rights would be affected.

According to Montana State water law, if a site was historically a wetland and is being restored to a wetland, no water right is needed. The Story Mill project area occurs just upstream from the confluence of Bozeman Creek and the East Gallatin River. Just by its topographic position in the landscape one would expect this area to be extremely wet. The South Parcel is in fact very wet as evidenced by the high groundwater table expressed at the pond and recorded in the 15 groundwater wells installed across the site, the need for a drainage ditch that crosses the property, and the several acres of existing wetlands currently found on the site. Furthermore, the Gallatin Local Water Quality District's 2004 report on wetlands and riparian resources in the Gallatin Valley indicate that the Story Mill project area was a wetland riparian area (English and Baker 2004). Based on this information it appears that restoration actions will not require a water right.

7.1.5 Vegetation Analysis

RESPEC's restoration design process considered several sources of information to better understand the composition and condition of vegetation currently occurring on the site. These sources of information included the following:

- Interpretation of historic aerial photography to better understand historic land uses and land management of the site
- The wetland delineation of the site completed by River Design Group Inc. in July 2012 [River Design Group Inc., 2012]
- The *Story Mill Vegetation Management Plan* [TerraQuatic, 2013]
- On-site field investigations in July and August 2013.

Native vegetation occurring within the project area has been highly disturbed by historic agricultural activities, such as land clearing and haying. Use of the site by livestock may have also occurred, but in a limited capacity. Current conditions of the vegetation occurring on the site reflect years of neglect and poor land management. Much of the site is dominated by state-listed noxious weeds, such as common tansy and Canada thistle. Many of the wetland areas found on site are dominated by invasive species, such as reed canarygrass, Garrison creeping foxtail, or broadleaf cattail. Smooth brome and other introduced pasture grasses are also common.

There are five general vegetation communities on the Story Mill project site: wetlands, riparian areas, upland herbaceous areas, an aspen forest, and the farmstead area (Appendix B). Plant species observed in each of these areas, and their relative abundance in the project area, are listed in Appendix B.

The design approach toward vegetation and revegetation on the site was to include the following:

- Minimize disturbances to the extent practicable
- Maintain existing mature woody vegetation, such as cottonwoods in riparian areas and around the farm house
- Use native plant species able to compete with existing vegetation
- Ongoing irrigation and maintenance would not be possible, so the use of containerized plant material outside of wetland areas would not be possible
- Noxious weed control would continue to be implemented on the site
- Develop native seed mixes based on predicted water regimes (i.e., upland, riparian, and wetland) that use commercially available plant seed for species occurring on site or in the project vicinity.

7.1.6 Projected Wetland Establishment

Proposed restoration actions in the conceptual alternatives attempt to maximize wetland development, while adhering to specific design constraints and criteria, included not allowing the adjacent landowners' properties to become wetter than they already area.

Establishing new wetland areas was projected based on these restoration actions, as well as several pieces of information that integrate climatic, hydrologic, vegetation, physical soil information, and the site's pre-settlement/ecological potential. Recorded groundwater elevations and modeled gradients on the South Parcel for May 19, 2013, include the following:

- Depth to groundwater below ground surface on the South Parcel in May and June 2013

- Existing wetland footprint as determined in July 2012 [River Design Group Inc., 2012]
- Field observations of hydrophytic vegetation outside of the wetland boundaries
- Soil texture (clay, silty clay loam, or coarser) and ability for capillary rise in the soils
- Predicted 2-year flood elevations of Bozeman Creek and the East Gallatin River.

7.1.7 Cost Estimating

Unit costs were obtained from RSMeans *Site Work and Landscape Cost Data for 2012* [RSMeans, 2012], RESPEC local and regional experience, the Montana Department of Transportation (MDT) average bid prices 2012, Federal Highway Administration (FHWA) bid documents, and from vendors. Subtotal costs were rounded up to the nearest \$100. Mobilization was assumed to be 20 percent of the total cost; a 10 percent contingency was included for items that were overlooked or underpriced; and a 1-year, 3 percent inflationary value was included in the totals.

It is important to understand that there are, typically, multiple options available for excavation and other earthwork that will vary by contractor based on the equipment that they own or are able to acquire and use on the project. The methods assumed for use in the conceptual cost estimates are one reasonable approach with associated representative costs.

Every effort was made to provide realistic costs; however, there are many assumptions that are required to be able to make a cost estimate. These assumptions are briefly covered in Section 7.2 and are provided in more detail in Appendix C.

7.2 Assumptions

A complete list of all of the assumptions used in the development of the conceptual alternatives is provided in Appendix C. Assumptions common to all three alternatives are listed below.

Global Assumptions

1. Unit costs were developed from a variety of standard cost-estimating sources including: RSMeans cost data (national cost data base), MDT unit prices, specific quotes from local and regional suppliers/vendors, and cost information from other similar projects maintained by local RESPEC staff.
2. Project implementation would incorporate standard contracting format and would be conducted during a favorable construction window.
3. The following buffer distances would be maintained for buried utility lines (i.e., gas, sewer, and water):

<u>Utility</u>	<u>Horizontal Buffer</u>	<u>Vertical Buffer</u>
Natural Gas	20 feet from line	No disturbance of existing ground surface <i>(NOTE: This was changed to 25' from line for the Selected Alternative).</i>
Sanitary Sewer	5 feet from line	Maintain minimum 5 feet of cover
Water	5 feet from line	Maintain minimum 6.5 feet of cover

4. Overhead electric power poles would maintain the existing ground elevation at their base and extend a minimum of 5 feet in any direction from the base. Any grading outside of this circle would only occur at a 5H:1V slope or less.
5. Building/structure removal would include all above-ground portions of the structures as well as foundations, slabs-on-grade, and bridge abutments. No asbestos or lead paint is present in the buildings.
6. Excavated material generated from on-site grading consists of existing surface vegetation and clean soil. Material does not contain large debris or hazardous materials. Excess, excavated soil material would be disposed of on site, primarily within the North Parcel.
7. No hazardous materials occur on site.

7.3 Design Constraints

The following constraints were considered during the restoration design:

- The East Griffin Road and bridge over the East Gallatin River cannot be moved or modified
- The Osterman property and the Sebens property should not become more wet as a consequence of wetland development on the South Parcel
- Restoration activities cannot occur on the Bryant Street right-of-way (South Parcel)
- No disturbance within 25 feet of the natural gas pipeline (South Parcel)
- No disturbance within 5 feet of the sewer pipelines (South Parcel)
- No disturbance within 5 feet of the water pipelines (South Parcel)
- Overhead electric lines occur on the North Parcel
- There are no surface water rights associated for the property
- The Story Mill Spur Trail occurs along the railroad right of way, which cannot be modified; this includes the railroad bridge over the east Gallatin River
- Maintain mature cottonwood trees in the vicinity of the farmhouse

- Maintain mature cottonwoods along the East Gallatin River on the North Parcel
- Invasive plants, such as reed canarygrass, Garrison creeping foxtail, and cattails, may limit the extent to which native vegetation is able to become established
- The watershed is becoming more urbanized, which could continue to exacerbate the timing, magnitude, and frequency of discharge in response to snowmelt and rain events
- Non-point-source pollution will continue to enter the project site from upstream sources.

8.0 RESTORATION ALTERNATIVES

The three restoration alternatives are generally described in Chapter 5.0 of this report. These three alternatives progress from the most extensive restoration activities in (Alternative 1–Ecological Restoration I), to more modest restoration activities (Alternative 2–Ecological Restoration II), to a minimum level of planned restoration activities (Alternative 3–Passive Restoration). These three alternatives are compared and contrasted in Table 8-1 through the use of an evaluation matrix with 18 different metrics (Chapter 6.0 also provides descriptions of the metrics). A summary costing table is provided in Table 8-2, and figures are included in Appendix D.

Table 8-1. Evaluation Matrix for Three Conceptual Restoration Design Alternatives Proposed For the Story Mill Project Area

Evaluation Criteria		Alternative		
		Restoration I	Restoration II	Passive Restoration
1.	Probability of meeting ecological objectives (low, moderate, high)	High	High–Moderate	Moderate–Low
2.	Relative complexity of project; difficulty of implementation (low, moderate, high)	Moderate	Moderate	Low
3.	Relative level of uncertainty in project outcome (low, moderate, high)	Low–Moderate	Low–Moderate	Low
4.	Acres of riverine wetland habitat restored at project completion (acres)	1.4	0.6	0
5.	Acres of slope wetland habitat restored at project completion (acres)	6.7	6.6	0
6.	Perimeter-area ratio of largest, contiguous wetland polygon (feet:square feet)	0.01	0.015	0.028
7.	Montana Wetland Assessment functional units	110	105	65
8.	Extent of ponded open water (acres)	0.2	0.03	0.5
9.	Total acres of temporary disturbance (acres)	11.4	8.7	1.4
10.	Acres of restored riparian habitat within 5 years of project completion (acres)	5.4	3.9	0
11.	Increase in the length of streambank where creek is allowed to freely access its active floodplain (feet) ^(a)	1,375.	830.	0
12.	Increase in the extent of floodplain area (acres)	5.0	1.5	0
13.	Length of East Gallatin River streambanks and streambed on TPL property that are free of direct human-imposed constraints (feet)	2,600 (100%)	2,580	1,030
14.	Estimated cubic yards of excavation (cubic yards)	28,410	10,410	1,840
15.	Estimated construction cost (excluding demolition)	\$485,800	\$331,500	\$102,300
16.	Estimated demolition cost	\$248,100	\$139,200	\$139,200
17.	Estimated cost of building maintenance	\$10,000	\$30,000	\$80,000
18.	Number of public access points to creek	3	3	1

(a) The active floodplain is defined as the area subject to flooding during the 2-year flood event.

Table 8-2. Summary Costs of Restoration Design Elements at the Story Mill Project Area (Estimated by M. Johnson and Reviewed by M. Rotar and R. McEldowney September 10, 2013) (Page 1 of 2)

Story Mill Restoration Alternatives—Conceptual Cost Estimate by Parcel and Alternative			
	Restoration I (\$)	Restoration II (\$)	Passive Restoration (\$)
North Parcel			
Expand East Gallatin River floodplain, excavate fill	76,800	33,700	33,700
Pedestrian river access	3,700	3,700	3,700
Restore wetland and vegetative diversity ^(a)	0	0	0
River corridor cleanup—remove riprap and trash	5,400	5,400	5,400
North Parcel Subtotal	85,900	42,800	42,800
South Parcel			
Remove farm buildings	84,600	84,600	84,600
Keep driveway up to bend for trail	1,100	1,100	1,100
Reconfigure pond/ditch ^(b)	0	0	0
Excavate Bozeman Creek floodplain, expand water-quality potential	27,600	0	0
Restore wetland and vegetative diversity	112,400	108,100	108,100
Pedestrian wetland observation trails	14,700	14,700	14,700
Multiuse connector trail	17,000	17,000	17,000
River corridor cleanup—remove riprap and trash	3,100	0	0
South Parcel Subtotal	260,500	225,500	225,500
Triangle Parcel			
Remove garage	20,000	20,000	20,000
Remove slaughterhouse buildings	81,900	0	0
Remove bridge	7,300	0	0
Pedestrian river access (convert driveway)	1,900	1,900	1,900
Truncate driveway at house ^(b)	0	0	0
Expand East Gallatin floodplain, excavate fill, expand water-quality potential	80,800	18,200	18,200
Restore wetland and vegetative diversity	9,900	41,900	41,900

Table 8-2. Summary Costs of Restoration Design Elements at the Story Mill Project Area (Estimated by M. Johnson and Reviewed by M. Rotar and R. McEldowney September 10, 2013) (Page 2 of 2)

Story Mill Restoration Alternatives—Conceptual Cost Estimate by Parcel and Alternative			
	Restoration I (\$)	Restoration II (\$)	Passive Restoration (\$)
Triangle Parcel (Continued)			
River corridor cleanup—remove riprap and trash	3,500	3,500	3,500
Triangle Parcel Subtotal	205,300	85,500	85,500
Alternative Subtotal	551,700	353,800	353,800
Mobilization—General Requirements (20%)	110,400	70,800	70,800
10% Contingency	55,200	35,400	35,400
1-Year Inflation (3%)	16,600	10,700	10,700
Conceptual Construction Cost Estimate	733,900	470,700	470,700

(a) Item included within expand East Gallatin River floodplain category

(b) Item included within restore wetland and vegetative diversity category.

9.0 SELECTED ALTERNATIVE

The Trust for Public Land reviewed the three conceptual alternatives and selected design elements that provided the most overall benefit for the proposed park, in consideration of the stated goals, previous stakeholder and community input, and budgetary considerations. The resulting combination of design elements is termed the ‘selected alternative’ though it is comprised of design elements from all three conceptual alternatives, as well as some new or ‘revised’ design elements that were developed in response to the alternative conceptual designs. The design elements of the selected alternative are summarized in the following tables (Tables 10 and 11), and depicted in figures provided in Appendix E.

Restoration design elements of the selected alternative includes:

South Parcel: the proposed actions for Restoration I Alternative with some modifications, including removal of the beaver ponds, naturalization of the existing pond, reducing the extent of the proposed fill in the drainage ditch north of the pond to maintain current hydrologic conditions on the Sebens property, maintain driveway north of the farm buildings, maximize 2-year floodplain area in the Bozeman Creek slough.

North Parcel: the proposed actions for Restoration I Alternative with some modifications, including maximization of the 2-year floodplain area.

Triangle Parcel: the proposed actions for Restoration II Alternative with some modifications, including the maximization of the 2-year floodplain on the left bank, and a bank treatment with a bankfull bench on the right bank.

Table 9-1. Evaluation Matrix for the Selected Conceptual Restoration Design Alternative Proposed for the Story Mill Project Area.

Evaluation Criteria	Selected Alternative
1. Probability of meeting ecological objectives (low, moderate, high).	High
2. Relative complexity of project; difficulty of implementation (low, moderate, high).	Moderate
3. Relative level of uncertainty in project outcome (low, moderate, high).	Low-Mod
4. Acres of riverine wetland habitat restored at project completion.	2.0 acres
5. Acres of slope wetland habitat restored at project completion.	6.1 acres
6. Perimeter-area ratio of largest, contiguous wetland polygon (feet:sq. ft.).	0.01
7. Montana Wetland Assessment Functional Units.	110
8. Extent of ponded open water (acres).	0.5 acres
9. Total acres of temporary disturbance.	11.4 acres
10. Acres of restored riparian habitat within 5 years of project completion.	2.8 acres
11. Increase in the length of streambank where creek is allowed to freely access its active floodplain (feet).*	1,375 ft.
12. Increase in the extent of floodplain area (acres).	2.9 acres
13. Length of East Gallatin River streambanks and streambed on TPL property that are free of direct human imposed constraints (feet).	2,600 ft. (100%)
14. Estimated cubic yards of excavation.	20,250 cy
15. Estimated construction cost (excluding demolition).	\$435,300
16. Estimated demolition cost.	\$139,200
17. Estimated cost of building maintenance.	\$30,000
18. Number of public access points to creek.	3
*The active floodplain is defined as the area subject to flooding during the 2-year flood event.	

Table 9-2. Summary Costs of Restoration Design Elements for the Selected Alternative at the Story Mill Project Area (Page 1 of 2)

Conceptual Cost Estimate for the Selected Alternative	
	Selected Alternative (\$)
North Parcel	
Expand E. Gallatin R. floodplain, excavate fill	76,800
Pedestrian river access	3,700
Restore wetland and vegetative diversity ¹	0
River corridor cleanup - remove riprap and trash	5,400
North Parcel Subtotal	85,900
South Parcel	
Remove farm buildings	84,600
Keep driveway up to bend for trail	1,100
Reconfigure pond/ditch ²	0
Excavate Bozeman CK floodplain, expand water quality potential	27,600
Restore wetland and vegetative diversity	112,400
Pedestrian wetland observation trails	14,700
Multi-use connector trail	17,000
River corridor cleanup - remove riprap and trash	3,100
South Parcel Subtotal	260,500
Triangle Parcel	
Remove garage	20,000
Remove slaughterhouse buildings	0
Remove bridge	0
Pedestrian river access (convert driveway)	1,900
Truncate driveway at house ²	0
Expand E. Gallatin floodplain, excavate fill, expand water quality potential	18,200
Restore wetland and vegetative diversity	41,900
River corridor cleanup - remove riprap and trash	3,500
Triangle Parcel Subtotal	85,500

Table 9-2. Summary Costs of Restoration Design Elements for the Selected Alternative at the Story Mill Project Area (Page 2 of 2)

Conceptual Cost Estimate for the Selected Alternative	
	Selected Alternative
Property Subtotal	431,900
Mobilization - General Requirements (20%)	86,400
10% Contingency	43,200
1-Year Inflation (3%)	13,000
Conceptual Construction Cost Estimate	574,500
¹ Item included within Expand E. Gallatin River Floodplain category ² Item included within Restore wetland and vegetative diversity category	

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APPENDIX A

**HYDROLOGIC AND HYDRAULIC ANALYSES FOR STORY MILL
RESTORATION PROJECT**



Technical Memorandum

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From: Matt Johnson, EI
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Date: September 14, 2013

Subject: Summary of Hydrologic and Hydraulic Analyses completed for the Story Mill
Ecological Restoration Project

Hydrologic and hydraulic analyses were completed for the East Gallatin River and Bozeman Creek through the Story Mill Ecological Restoration Project. Methods and results are provided in this memorandum.

HYDROLOGIC ANALYSIS

The hydrologic analysis performed for the Project includes both the East Gallatin River and Bozeman Creek. For both analyses, the United States Geological Survey (USGS) report titled, "Methods for Estimating Flood Frequency in Montana Based on Data through Water Year 1998" (Parrett and Johnson, 2004), hereinto referred as Water-Resources Investigations Report (WRIIR) 03-4308, was followed for calculating peak flows for several recurrence interval events. In that report, 660 gages throughout Montana were analyzed and correlated to various basin parameters and climatic characteristics to develop equations that estimate flood frequency at ungaged sites for the 2, 5, 10, 25, 50, 100, 200, and 500 year recurrence interval flood events, termed "regression equations". Additionally, this report outlines procedures for transferring a statistical gage analysis result from a gaged site to ungaged sites on the same stream. Transfer of gage analyses is considered more reliable than flood frequency discharge estimates generated by regression equations since the results are based on actual measurements rather than correlation of many regional measurements. Nonetheless, regression equations provide a reasonable and efficient means of generating flood frequency discharge estimates.

Bozeman Creek Hydrologic Analyses

Peak flow rates for several recurrence interval events were estimated for Bozeman Creek just upstream of its confluence with East Gallatin River. The 12-digit Hydrologic Unit Code watershed area for Bozeman Creek (51.9 mi²) was used for calculations. As mentioned, it is more reliable to transfer a statistical gage analysis to an ungaged site but for Bozeman Creek, the large difference in drainage area from the drainage area of the gage prevents calculation of a reliable estimate. WRIR 03-4308 suggests that the ratio of drainage areas of the ungaged site to the gaged site should be between 0.5 – 1.5 for a reliable estimate. The drainage area ratio for Bozeman Creek just upstream of the confluence with East Gallatin River is 0.35. Consequently, regression equations were used for flood frequency discharge estimates on Bozeman Creek. Provided in WRIR 03-4308 are regression equations developed for the Upper Yellowstone-Central Mountain Region, where the project site is located. These regression equations were used for development of peak flow rates on Bozeman Creek and relate drainage area (A) in square miles and the percent of drainage area above 6,000 feet of elevation (E_{6000}) to an estimated peak flow discharge of a particular event. The percent of the Bozeman Creek drainage area above 6,000 feet was obtained through processing a 10-m Digital Elevation Model of the watershed and was found to be 62.9% of the total 51.9 mi² drainage area. An excerpt of WRIR 03-4308 showing the regression equations is provided:

Regression equation	Error variance, log units		Average SEP, in log units	Average SEP, in percent	ETR
	Average sampling	Model			
Upper Yellowstone-Central Mountain Region (n = 92)					
$Q_2 = 5.84 A^{0.812} (E_{6000}+1)^{0.098}$	.005	.115	.348	94.9	1.5
$Q_5 = 21.7 A^{0.782} (E_{6000}+1)^{-0.0295}$	.004	.076	.282	72.7	3.2
$Q_{10} = 42.3 A^{0.758} (E_{6000}+1)^{0.0915}$	.004	.060	.252	63.4	5.6
$Q_{25} = 82.6 A^{0.733} (E_{6000}+1)^{-0.148}$	.004	.049	.230	57.1	9.5
$Q_{50} = 126 A^{0.716} (E_{6000}+1)^{-0.182}$	.004	.047	.226	55.9	12.2
$Q_{100} = 181 A^{0.702} (E_{6000}+1)^{-0.211}$	.005	.048	.229	56.8	14.2
$Q_{200} = 252 A^{0.689} (E_{6000}+1)^{-0.238}$	.005	.052	.239	59.5	15.4
$Q_{500} = 375 A^{0.674} (E_{6000}+1)^{-0.271}$	.006	.061	.258	65.2	15.9

As shown, 92 gages with peak flow record of various time frames were used in the development of the equations shown. Also provided is the Standard Error of Prediction (SEP) showing expected error ranging between 55.9 - 94.9% for this region. As shown in the excerpt above, the highest variability in prediction is for the more frequent flood events (2-year and 5-year). The results of the regression analysis are provided in Table 1.

Table 1. Peak flow estimates for Bozeman Creek just upstream of East Gallatin River confluence.

Peak Flow Recurrence Interval (yrs)	Bozeman Creek just upstream of East Gallatin River (cubic feet/second)[cfs]
2	235
5	421
10	577
25	807
50	1,000
100	1,200
200	1,420
500	1,740

East Gallatin River Hydrologic Analysis

Peak flow rates for several recurrence interval events were estimated for East Gallatin River just upstream of the confluence with Bozeman Creek. The 12-digit Hydrologic Unit Code watershed areas for the East Gallatin River – Kelly Creek, East Gallatin River – Bear Creek, East Gallatin River – Rocky Creek, and East Gallatin River – Jackson Creek were summed for a total East Gallatin River at Bozeman Creek drainage area of 99.3 mi². The Bozeman Creek watershed is not included within this drainage area.

A statistical gage analysis following procedures outlined in Bulletin 17B (USGS, 1982) was completed for USGS gage number 06048000 with a drainage area of 148 mi² during development of WRIR 03-4308. This gage is no longer in service but was located just downstream of the East Gallatin River-Bozeman Creek confluence and recorded 23 annual peak flow events, primarily between 1940 and 1961. A peak flow event from 1981 is also included. The results from their analysis include flow from Bozeman Creek. For East Gallatin River hydraulic model development, flows from Bozeman Creek are not desired so the results provided in WRIR 03-4308 must be transferred to just upstream of the confluence with Bozeman Creek. Described in WRIR 03-4308 are methods for transferring flood frequency estimates from a gaged site to an ungaged site to account for differences in contributing drainage area. The transfer of flood frequency results is accomplished through raising the ratio of the ungaged drainage area to the gaged drainage area to a regional exponent and multiplying by the peak flow estimate for the gage. An excerpt from WRIR 03-4308 showing this equation is provided:

$$Q_{T,U} = Q_{T,G} \left(\frac{DA_U}{DA_G} \right)^{\exp_T},$$

where

$Q_{T,G}$	is the T -year flood at the gaged site, in cubic feet per second,
DA_U	is the drainage area at the ungaged site, in square miles,
DA_G	is the drainage area at the gaged site, in square miles, and
\exp_T	is the regression coefficient for a simple OLS regression relating the log of T -year flood to log of drainage area within each region (table 13).

In addition to peak flow estimates obtained through transfer of the USGS 060480000 statistical gage result, the same regression equations utilized for development of Bozeman Creek peak flows were also calculated for the East Gallatin River for comparison purposes. The gage results, gage transfer results and results of the regression equations are provided in **Table 2**.

Table 2. Peak flow estimates for USGS gage #060480000, transfer of those results to East Gallatin River just upstream of Bozeman Creek, and results generated by regression equations for East Gallatin River just upstream of Bozeman Creek.

Peak Flow Recurrence Interval (yrs)	USGS 060480000* (cfs)	East Gallatin River just upstream of Bozeman Creek (Gage Transfer) (cfs)	East Gallatin River just upstream of Bozeman Creek (Regression Equation) (cfs)
2	549	387	390
5	860	633	707
10	1,100	828	973
25	1,450	1,120	1,364
50	1,740	1,360	1,689
100	2,050	1,620	2,040
200	2,400	1,920	2,410
500	2,910	2,360	2,950

*source: WRIR 03-4308

Hydrologic Discussion

The peak flow estimates calculated for the Story Mill Ecological Restoration Project are not exact and have inherent error that can be attributed to their statistical origin and to flow measurement error. For the East Gallatin River just upstream of Bozeman Creek, the 2-year event estimate generated by regression equation differs by less than 1% from the gage transfer result which inspires a degree of confidence. The less frequent events differ by about 20% which suggests less confidence in the regression equation for this site. Regardless, calculation of peak flow by both methods provides a good comparison and check. The results generated by gage transfer were utilized in the East Gallatin River hydraulic model since these results are considered more reliable than those estimated by regression. Regression equations were used to generate flood frequency discharge estimates for Bozeman Creek since gage transfer to this ungaged site is not appropriate due to the drainage area ratio falling outside the suggested range of applicability.

An intuitive exercise might be to sum peak flow estimates for the same recurrence interval event for Bozeman Creek and East Gallatin River, and to expect those results to be similar to those predicted for USGS gage #060480000. In fact, summing those results does not produce the same gage result. This is not surprising because it should not be assumed that these flooding sources have coincident peak flows. In other words, the different geomorphic and climatic characteristics of the two basins produce different timing of their respective peak flows.

The results utilized in both the Bozeman Creek and East Gallatin River hydraulic models are considered reliable since both methodologies are industry accepted, the methods were developed with actual measured flows taken over numerous years, and the results agree well with previous studies (FEMA, 2011).

HYDRAULIC ANALYSIS

The peak flow estimates described above were utilized in the hydraulic models for both East Gallatin River and Bozeman Creek throughout the project area (**Figure 1**). A steady-state peak flow analysis was completed for both reaches using the standard-step backwater model HEC-RAS 4.1 (USACE, 2010).

Geometry

Recently acquired high resolution LiDAR topographic data (DNRC, 2013) was the basis for creation of the existing conditions geometry for both reaches (**Figure 2, Figure 3**). Cross sections were drawn in ArcMap 10.1 and station-elevation information was extracted to HEC-RAS from the LiDAR topography. Reach lengths were extracted from the intersections of the stream centerline and overflow lines with each cross section. Typical Manning's roughness values for mountain streams and vegetated floodplains (Chow, 1959) were used for both the existing and proposed conditions. Manning's values used for the channel ranged between 0.035 – 0.04 and Manning's values used for the overbank areas ranged from 0.05 – 0.08.

Hydraulic Structures

The two existing bridges were modeled on Bozeman Creek and three existing bridges were modeled on East Gallatin River. The structures modeled on Bozeman Creek are at Griffin Drive and the private driveway to the storage unit facility adjacent to the project area. The structures modeled on East Gallatin River were at Griffin Drive, the Story Mill Spur Trail, and the Triangle Parcel Bridge. There are two bridges located at the Story Mill Spur Trail but due to their close proximity they were modeled as a single bridge using the combined restrictive dimensions. For all structures, approximate dimensions were used in the model and obtained through extraction from the LiDAR topography, field survey, field reconnaissance, and photographs. For the Restoration I model, the Triangle Parcel Bridge was removed.

Non-conveyance Areas

It is apparent that the analyzed reaches are comprised of multiple areas considered backwater or that can be assumed to contain limited conveyance in the stream wise direction upon inspection of iterative inundation mapping during model development. The Ineffective Flow Area method within HEC-RAS was used to correctly and conservatively calculate the total effective conveyance for each cross section for these areas. Cross sections bounding hydraulic structures were also assigned areas of non-conveyance to force the one-dimensional steady state model to more accurately calculate the headloss due to flow contraction and expansion.

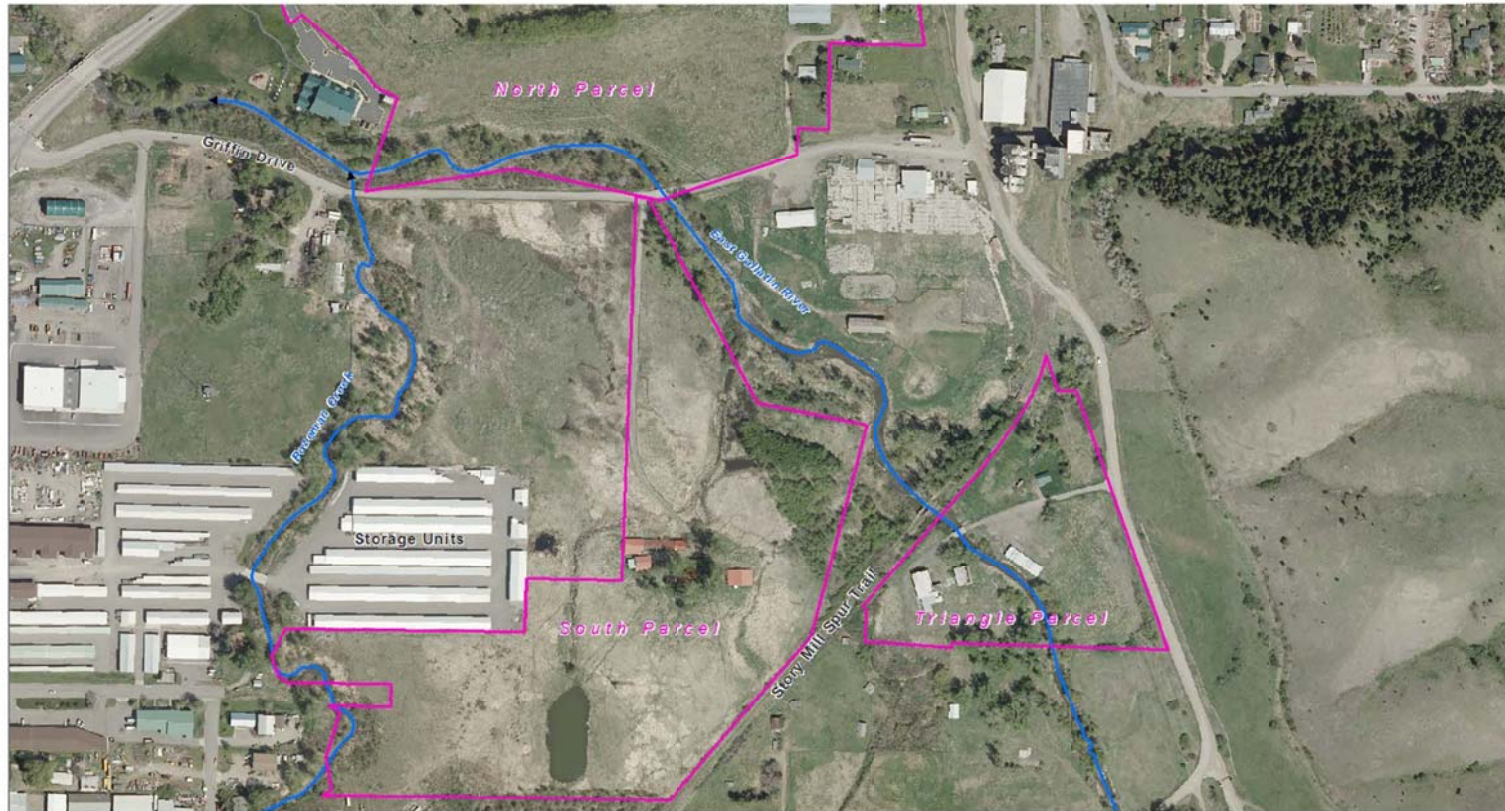


Figure 1. Bozeman Creek and East Gallatin River through the Story Mill Ecological Restoration Project Area.



Figure 2. Geometric layout of Bozeman Creek hydraulic model.



Figure 3. Geometric layout of East Gallatin River hydraulic model.

Proposed Design

Using existing geometry created with LiDAR, floodplain modifications were imposed for two areas along the East Gallatin River (North Parcel and Triangle Parcel) and for one area along Bozeman Creek (South Parcel). The predicted 2-year and 5-year events were evaluated for establishment of floodplain elevations. The proposed flood inundation mapping for the 2-year and 5-year events are shown on **Figure 4** and **Figure 5**, respectively.

The Bozeman Creek Overflow Swale was designed such that the swale is activated at the 2-year event (approximately a bankfull event). Major design constraints for this feature are the City of Bozeman Right Of Way that protrudes across the channel into the South Parcel and the existing robust stand of willows established along the top of the right bank. These features were avoided which resulted in the alignment of the swale shown on **Figure 4**. Additionally, creation of thalweg elevations of the swale lower than Bozeman Creek was avoided to reduce lateral flow (i.e., drainage) potential from Bozeman Creek to the swale. Also, the inlet and outlet elevations were carefully selected to reduce the likelihood of Bozeman Creek relocating to the swale. The inlet to the swale was created just above the bankfull elevation to prevent any modifications to the bank. A narrow inlet with constant elevation over approximately 100 feet was established to reduce the proportion of flow entering the swale for all events. For the conceptual design, it was discovered that Bozeman Creek backwater enters the swale outlet and controls flow for about half the feature length. Many options are possible to control flow characteristics in the swale such as: stage at which flow enters the inlet, stage at which backwater enters the outlet, the proportion of flow desired to enter the swale, the roughness, depth, and flow area. It is important to note that creation of this feature may encourage additional flow to the interior project area. This was observed at the 10-year event and greater and shown on **Figure 6**. Additional flow input to the interior South Parcel may be mitigated or enhanced by strategic grading (e.g., a berm).

Proposed floodplain modifications to the East Gallatin River were based on existing channel conditions and its relationship to the floodplain. Floodplain grading was designed based on interaction with the 2-year and 5-year flow events and the existing channel/floodplain setting. For both the North and Triangle Parcels, the floodplain becomes activated at the 2-year event (**Figure 4**) and becomes more inundated during the 5-year event (**Figure 5**). Several design constraints exist for the North Parcel including: existing mature trees and willows lining the right bank, utility poles, and the left overbank floodplain elevation along the inside of the bend. Several gaps within the mature woody vegetation are present and will be utilized to allow flow to enter the proposed floodplain area. The major design constraint prevalent on the Triangle Parcel is the location of the permanent bridges (Story Mill Spur Trail bridges – both action alternatives, Slaughterhouse Bridge – Alternative 2). For Alternative 2, leaving the slaughterhouse buildings and access bridge prevents substantial expansion of the floodplain along the left bank and limits the floodplain width on both overbanks as it approaches the existing bridges.

These conceptual designs utilized basic floodplain geometries for the hydraulic analysis and cost estimate. Once the preferred alternative is selected, natural and irregular features will be incorporated into features during final design of the selected alternative. Additionally, within physical constraints, the proposed floodplain elevations can be modified to favor lesser

magnitude events without significant changes in cost since accounting for the majority of excavation volume has occurred.

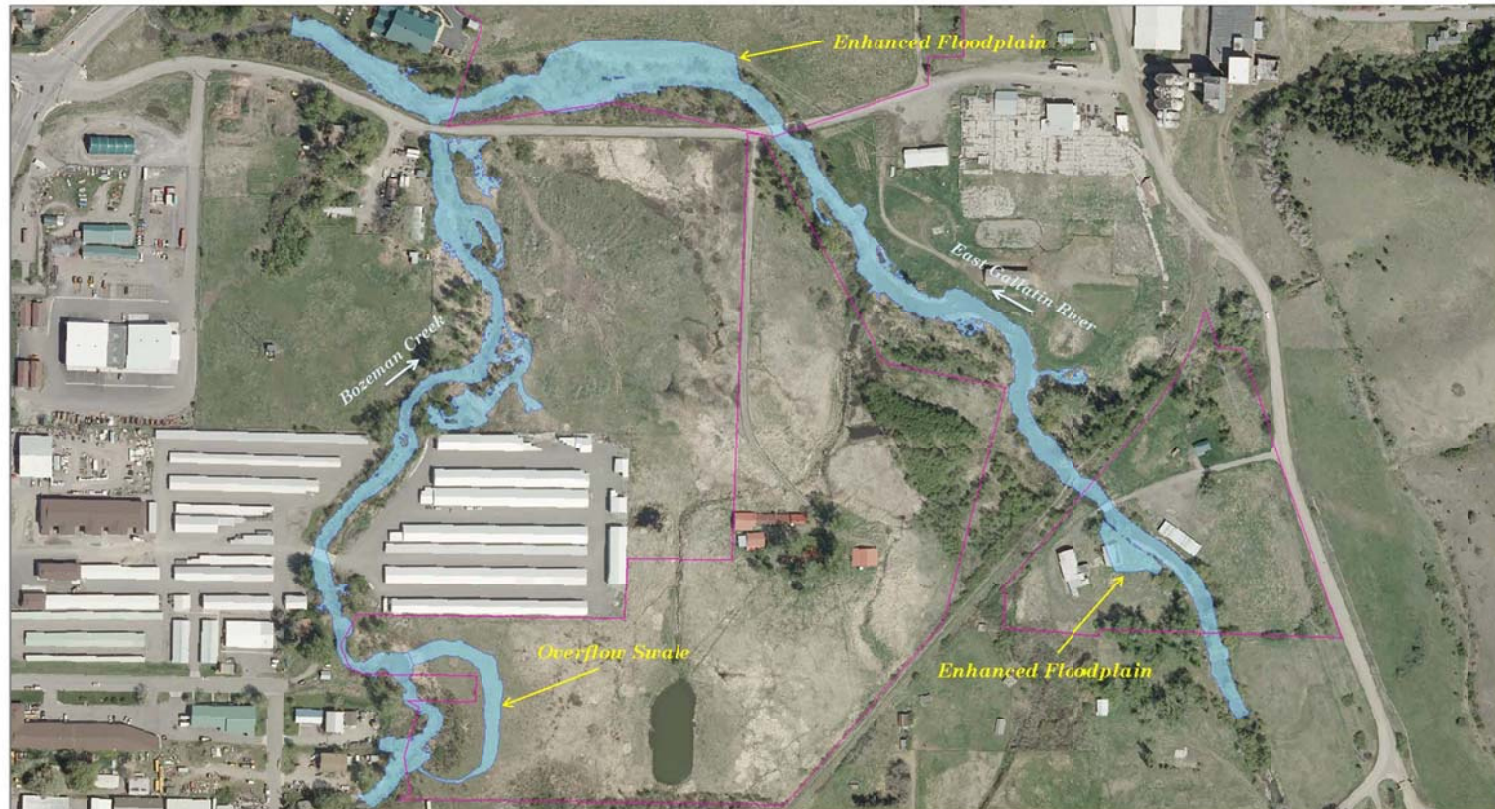
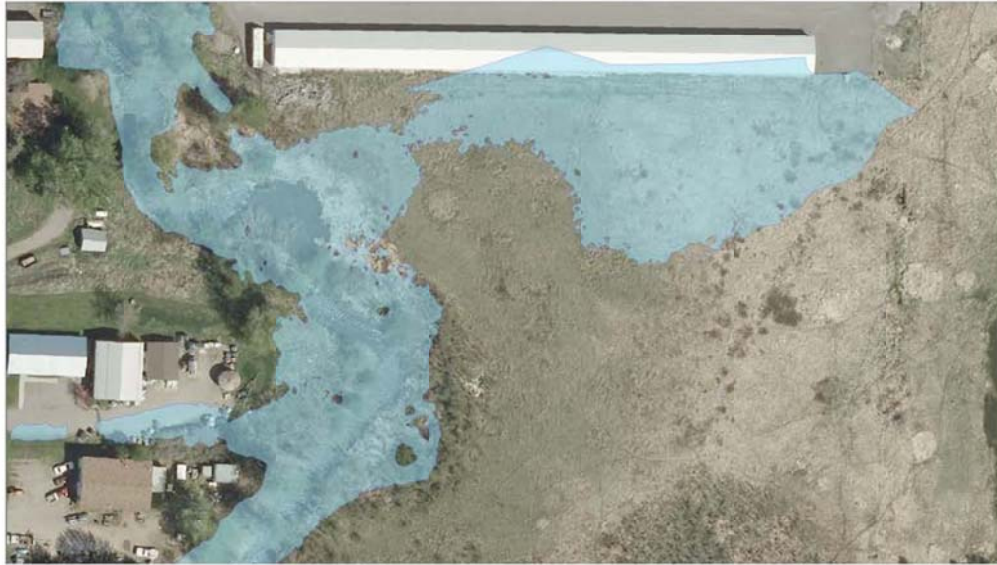


Figure 4. Proposed 2-year flood inundation map of Story Mill Restoration project site (Restoration I Alternative).



Figure 5. Proposed 5-year flood inundation map of Story Mill Restoration project site (Restoration I Alternative).

Bozeman Creek Existing Conditions – 10 Year Flood Event

At the 10-year event, it is evident that a portion of flow leaves the Bozeman Creek system into the South Property (not modeled).

Bozeman Creek Proposed Overflow Swale – 10 Year Flood Event

The proposed model which includes the Overflow Swale may encourage additional flow loss into the South Property. It may be desirable to construct a berm along the northeast corner of the swale feature to reduce potential additional flooding.

Figure 6. Existing and proposed 10-year flood inundation for the Bozeman Creek Overflow Swale.

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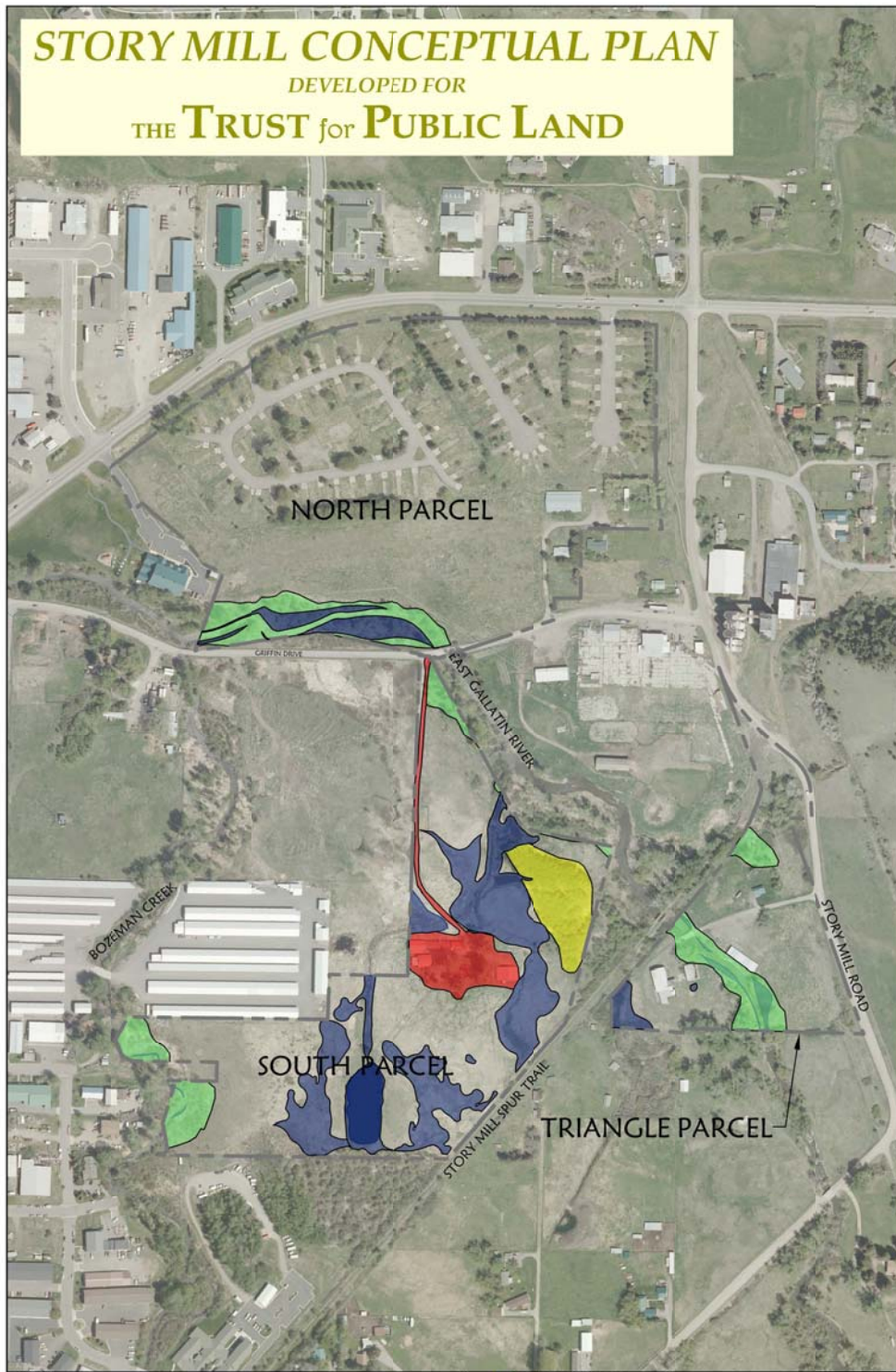
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APPENDIX B

PLANT SPECIES IN THE STORY MILL PROJECT AREA

STORY MILL CONCEPTUAL PLAN

DEVELOPED FOR
THE TRUST for PUBLIC LAND



LEGEND
HABITAT = UPLAND HERBACEOUS UNLESS
OTHERWISE NOTED
WETLAND
RIPARIAN
ASPEN FOREST
HOMESTEAD
APPROXIMATE PROPERTY LINE



0 300 600
FEET

RESPEC
WATER & NATURAL RESOURCES
3810 VALLEY COMMONS DRIVE
SUITE 4
BOZEMAN, MT 59718
www.respec.com

VEGETATION MAP

DR	JR	DATE	10/14/2013	REV
DR	MR	SCALE	RSI WVG NO.	0
DR	RM			

Table B-1. Plant Species Observed on the Story Mill Project Area (Surveyed by Ms. Andrea Pipp on July 23, 2013)
(Page 1 of 10)

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
<i>Parcel</i>				<i>South</i>	<i>Triangle</i>	<i>South</i>	<i>South</i>	<i>North</i>	<i>Triangle</i>	<i>South</i>	<i>Triangle</i>	<i>South</i>	
TREES													
<i>Acer</i> species	maple seedlings	unknown	---				IF						Seedlings of less than one foot observed in several places, but mature tree/shrub not observed.
<i>Fraxinus pennsylvanica</i>	green ash	native	FAC			IF							
<i>Juniperus scopulorum</i>	Rocky Mountain juniper	native	---			VC							Probably a couple of juniper varieties or species are present at homestead.
<i>Malus</i> species	crab apple	unknown	---			IF							Probably a horticultural species.
<i>Populus balsamifera</i>	cottonwood	native	FAC			VC	VC	VC	VC				Hybrids may be present.
<i>Populus tremuloides</i>	quaking aspen	native	FACU		IF	F	IF					VC	In Upland Herbaceous-Parcel 3 it is found along Story Mill Road.
<i>Pseudotsuga menziesii</i>	Douglas-fir	native	FACU			F							
<i>Salix fragilis</i>	weeping willow	exotic	FAC			VC	VC	VC	VC				May be hybrids with <i>S. alba</i> .
<i>Sorbus</i> species	mountain ash	unknown	---			IF							Probably a horticultural species.
SHRUBS													
<i>Alnus incana</i>	speckled alder	native	FACW				VC	F					

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
Parcel				South	Triangle	South	South	North	Triangle	South	Triangle	South	
<i>Cornus sericea</i> syn. <i>C. alba</i> , <i>C. stolonifera</i>	red-osier dogwood	native	FACW				F	F	F		IF		Population seems suppressed.
<i>Lonicera</i> species	honeysuckle	unknown	---						F				Probably a horticultural species.
<i>Prunus virginiana</i>	chokecherry	native	FACU	IF	IF	VC	VC		VC			IF	Species or variety at homestead may differ from other parcels. In Upland Herbaceous-Parcel 3 it forms a row at the southeast boundary.
<i>Rhus trilobata</i>	skunkbush sumac	native	---			IF							
<i>Ribes aureum</i>	golden currant	native	FAC			F	F		IF				
<i>Ribes</i> species	currant	unknown	---			F	F		IF				
<i>Rosa acicularis</i>	prickly rose	native	FACU	IF									
<i>Rosa woodsii</i>	Woods' rose	native	FACU			IF	F	F	IF			F	
<i>Salix boothii</i>	Booth's willow	native	FACW	IF		IF	VC	VC	IF	F			
<i>Salix exigua</i>	streamside or coyote willow	native	FACW				F	VC	IF	IF	F		VC in southwest portion of Parcel 1.
<i>Salix lutea</i>	yellow willow	native	OBL				F			F			
<i>Symphoricarpos occidentalis</i>	western snowberry	native	UPL	F		F	F	F	F			F	
<i>Syringa</i> species	Lilac	exotic	---			VC							
FORBS													
<i>Achillea millefolium</i>	common	native	FACU	IF									

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
Parcel				South	Triangle	South	South	North	Triangle	South	Triangle	South	
	yarrow												
<i>Arctium minus</i>	lesser burdock	exotic	UPL	IF	F	IF	F		F				
Asteraceae	Aster Family	unknown	---			IF							Possibly a horticultural species.
<i>Berteroa incana</i>	hoary alyssum	exotic (State noxious)	---	IF	F	IF		IF					
Brassicaceae	Mustard Family	unknown	---							IF			
<i>Capsella bursa-pastoris</i>	Shepherd's purse	exotic	FACU	IF									
<i>Carduus nutans</i>	musk thistle	exotic (County noxious)	UPL		F								Primarily in the driveway.
<i>Centaurea maculosa</i>	spotted knapweed	exotic (State noxious)	---	F	F								
<i>Cirsium arvense</i>	Canada thistle	exotic (State noxious)	FAC	VC	VC	VC	VC			VC		F	
<i>Cirsium vulgare</i>	bull thistle	exotic	FACU	IF			IF		IF	IF			
<i>Conium maculatum</i>	poison hemlock	exotic (State noxious)	FAC		IF				IF				Border of upland and riparian habitats.
<i>Cynoglossum officinale</i>	hound's-tongue	exotic (State noxious)	FACU	F	F	F			F			IF	
<i>Epilobium ciliatum</i>	fringed willowherb	native	FACW							IF			

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
Parcel				South	Triangle	South	South	North	Triangle	South	Triangle	South	
<i>Euphorbia esula</i>	sulfur cinquefoil	exotic (State noxious)	---				F	IF				IF	Only in southeastern portion of Riparian Parcel 1.
<i>Galium aparine</i>	stickywilly	native	FACU		IF	IF							
<i>Geum macrophyllum</i>	large-leaved avens	native	FAC							IF			
<i>Glycyrrhiza lepidota</i>	licorice-root	native	FAC					F	IF				
<i>Heracleum lanatum</i> syn. <i>H. maximum</i>	cow parsnip	native	FAC	IF			IF					F	
<i>Hesperis matronalis</i>	dames rocket; mother-of-the-evening	exotic	FACU				IF						
<i>Iva xanthiifolia</i> syn. <i>Cyclachaena xanthiifolia</i>	carelessweed	native	FAC						IF				
<i>Lactuca serriola</i>	prickly lettuce	exotic	FACU	IF	IF								
Lamiaceae	Mint Family	unknown	---			IF							Possibly a horticultural species.
<i>Lemna minor</i>	duckweed	native	OBL							F			
<i>Lepidium draba</i> syn. <i>Cardaria draba</i>	whitetop	exotic (State noxious)	---	F									
<i>Leucanthemum vulgare</i> syn. <i>Chrysanthemum leucanthemum</i>	oxeye daisy	exotic (State noxious)	FACU				IF	IF				F	
<i>Linaria vulgaris</i>	yellow toadflax	exotic (State noxious)	---		F			F					

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
Parcel				South	Triangle	South	South	North	Triangle	South	Triangle	South	
<i>Lotus corniculatus</i>	bird's -foot trefoil	exotic	FAC			F							Occurs along driveway bordering Upland Herbaceous Parcel 1.
<i>Lysimachia ciliata</i>	fringed loosestrife	native	FACW				IF		IF				
<i>Matricaria matricarioides</i> syn. <i>M. discoidea</i>	pineapple weed	exotic	FACU		IF								
<i>Medicago lupulina</i>	black medick	exotic	FACU		IF					IF			
<i>Melilotus officinale</i>	yellow sweet clover	exotic	FACU		IF		IF	IF					
<i>Mentha arvensis</i>	field mint; American wild mint	native	FACW				IF			F			
<i>Plantago major</i>	common plantain	exotic	FAC							IF			
<i>Polygonum (aviculare)</i>	(prostrate) knotweed	exotic	(FAC)		IF					IF			Near wetland/upland edge
<i>Polygonum amphibium</i> syn. <i>Persicaria amphibia</i>	water smartweed	native	OBL				VC			F			
<i>Potentilla anserina</i> syn. <i>Argentina anserina</i>	common silverweed	native	OBL				F			IF			
<i>Ranunculus acris</i>	tall buttercup	exotic (State noxious)	FAC	IF				IF		IF		IF	Would be good to get a 2nd opinion on species.

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
Parcel				South	Triangle	South	South	North	Triangle	South	Triangle	South	
<i>Ranunculus sceleratus</i>	celery-leaved buttercup	native	OBL							IF			
<i>Rorippa curvipes</i>	bluntleaf yellowcress	native	FACW							IF			
<i>Rumex crispus</i>	curly dock	exotic	FAC		IF		IF			IF			
<i>Rumex fueginus</i> syn. <i>R. maritimus</i>	golden dock	native	FACW							IF			
<i>Silene latifolia</i> syn. <i>Lychnis alba</i>	white campion	exotic	---		IF				IF				Occurs on bank where overstory vegetation has been removed.
<i>Silene vulgaris</i>	maidenstears	exotic	---		IF								
<i>Sisymbrium</i> species	mustard	exotic	---	IF	IF	IF							
<i>Solanum dulcamara</i>	climbing nightshade	exotic	FAC						IF				
<i>Solidago canadensis</i>	Canada goldenrod	native	FACU					IF					
<i>Sonchus</i> species		exotic	---							IF			
<i>Tanacetum vulgare</i>	common tansy	exotic (State noxious)	FACU	VC	VC	VC	VC	VC	VC	F	IF	IF	
<i>Taraxacum officinale</i>	common dandelion	exotic	FACU	F	F	VC	VC			F			
<i>Thlaspi arvense</i>	field pennycress	exotic	UPL	IF	IF								
<i>Tragopogon dubois</i>	western salsify	exotic	---	IF	IF		IF						

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
Parcel				South	Triangle	South	South	North	Triangle	South	Triangle	South	
<i>Trifolium repens</i>	white clover	exotic	FAC							IF			
<i>Urtica dioica</i>	stinging nettle	native	FAC	IF					IF				
<i>Verbascum thapsus</i>	common mullein	exotic	FACU		IF	IF							
<i>Verbena bracteata</i>	prostrate or carpet vervain	exotic	FAC		IF								Occurs in driveway bordering Upland Herbaceous Parcel 1 and in Parcel 3.
GRASS / GRASS-LIKE													
<i>Agropyron repens</i> syn. <i>Elymus repens</i>	quack grass	exotic	FAC	VC	VC	VC	VC	VC	VC	VC	VC	IF	F
<i>Agrostis stolonifera</i>	redtop	exotic	FAC				VC	VC	VC	VC	VC	VC	F
<i>Alopecurus arundinaceus</i>	creeping meadow foxtail	exotic	FAC				VC	VC	VC	VC	VC		
<i>Alopecurus pratensis</i>	field meadow foxtail	exotic	FAC										Suspected to occur, but not observed on July 23, 2013.
<i>Bromus (carinatus)</i> syn. <i>B. (marginatus)</i>	California or mountain brome	native	---				F	F					
<i>Bromus inermis</i>	smooth brome	exotic	FAC	VC	VC	VC	VC	VC	VC				
<i>Bromus japonicus</i>	Japanese brome	exotic	---	IF	IF								near wetland/upland boundary
<i>Bromus tectorum</i>	cheatgrass	exotic (State regulated)	---		F								

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
Parcel				South	Triangle	South	South	North	Triangle	South	Triangle	South	
<i>Calamagrostis stricta</i>	slimstem reedgrass	native	FACW							F			
<i>Carex aquatilis</i>	water sedge	native	OBL							IF			
<i>Carex microptera</i>	small-wing sedge	native	FACU							IF			
<i>Carex nebrascensis</i>	Nebraska sedge	native	OBL				IF			VC	F		
<i>Carex pellita</i> syn. <i>C. lanuginosa</i>	woolly sedge	native	OBL							F			
<i>Carex praegracilis</i>	clustered field sedge	native	FACW	F						F			
<i>Carex vesicaria</i>	blister sedge	native	OBL							IF			
<i>Catabrosa aquatica</i>	water whorlgrass	native	OBL							IF			
<i>Dactylis glomerata</i>	orchard grass	exotic	FACU	IF		VC	F						
<i>Eleocharis palustris</i>	common spikerush	native	OBL							F			
<i>Equisetum arvense</i>	field horsetail	native	FAC				F	F	IF	F	F		
<i>Equisetum hyemale</i>	tall scouring rush	native	FACW	IF						IF			
<i>Glyceria grandis</i>	American mannagrass	native	OBL							IF			
<i>Hordeum brachyantherum</i>	meadow barley	native	FACW							F			

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
Parcel				South	Triangle	South	South	North	Triangle	South	Triangle	South	
<i>Hordeum jubatum</i>	foxtail barley	native	FAC		F	IF				IF			
<i>Juncus balticus</i> syn. <i>J. arcticus</i>	Baltic or Arctic rush	native	FACW				F			F	F		
<i>Juncus compressus</i>	roundfruit rush	exotic	OBL	IF			F			F			
<i>Juncus ensifolius</i>	swordleaf or dagger-leaf rush	native	FACW				IF						
<i>Juncus interior</i>	inland rush	native	FAC				F						
<i>Juncus longistylis</i>	long-style rush	native	FACW				IF						
<i>Juncus nodosus</i>	knotted rush	native	OBL				IF						
<i>Pharlaris arundinacea</i>	reed canarygrass	native	FACW	IF			F	F	IF	VC	VC		
<i>Phleum pratense</i>	common timothy	exotic	FAC	VC	F		F			F		F	
<i>Poa pratensis</i>	Kentucky bluegrass	exotic	FAC			VC	F			F		F	
<i>Scirpus microcarpus</i>	small-fruited, red-tinge, or panicled bulrush	native	OBL							F			
<i>Typha latifolia</i>	broad-leaf cat-tail	native	OBL							VC			

Species	Common Name	Nativity	Wetland Indicator*	Upland Herbaceous	Upland herbaceous	Homestead	Riparian	Riparian	Riparian	Wetland	Wetland	Aspen Forest	Notes
Parcel				South	Triangle	South	South	North	Triangle	South	Triangle	South	
VINE													
<i>Clematis ligusticifolia</i>	western white clematis	native	FAC						F				
<i>Polygonum convolvulus</i>	black bindweed	exotic	---			F							

*Wetland Indicator: Lichvar, R. 2012. *The National Wetland Plant List*. ERDC/CRREL TR-12-11. U.S. Army Corps of Engineers, Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. Obtained at <<http://rsgisias.crrel.usace.army.mil/NWPL>>.

Occurrence:

VC = Very Common occurrence

F = Frequent occurrence

IF = Infrequent occurrence

Nomenclature follows: Lesica, P. 2012. *Manual of Montana Vascular Plants*. Brit Press, Fort Worth, Texas.

No rare plants observed.

APPENDIX C

ASSUMPTIONS USED IN THE DEVELOPMENT OF THE CONCEPTUAL ALTERNATIVES

APPENDIX C

ASSUMPTIONS USED IN THE DEVELOPMENT OF THE CONCEPTUAL ALTERNATIVES

GLOBAL ASSUMPTIONS

1. Unit costs were developed from a variety of standard cost estimating sources including: RSMeans Cost Data (national cost database), Montana Department of Transportation (MDT) unit prices, specific quotes from local and regional suppliers/vendors, and cost information from other similar projects maintained by local RESPEC staff.
2. Project implementation would incorporate standard contracting format and would be conducted during a favorable construction window.
3. The following buffer distances would be maintained for buried utility lines (i.e., gas, sewer, and water):

<u>Utility</u>	<u>Horizontal Buffer</u>	<u>Vertical Buffer</u>
Natural Gas	20 feet from line	No disturbance of existing ground surface <i>(NOTE: This was changed to 25' from line for the Selected Alternative).</i>
Sanitary Sewer	5 feet from line	Maintain minimum 5 feet of cover
Water	5 feet from line	Maintain minimum 6.5 feet of cover

4. Overhead electric power poles would maintain the existing ground elevation at their base and extend a minimum of 5 feet in any direction from the base. Any grading outside of this circle would only occur at a 5H:1V slope or less.
5. Building/structure removal would include all aboveground portions of the structures as well as foundations, slabs-on-grade, and bridge abutments. No asbestos or lead paint is present in the buildings.
6. Excavated material generated from on-site grading consists of existing surface vegetation and clean soil. Material does not contain large debris or hazardous materials. Excess, excavated soil material would be disposed of on-site, primarily within the North property.
7. No hazardous materials occur onsite.

Alternative 1—Ecological Restoration I

North Parcel Assumptions

1. Excavated material generated from floodplain grading would be placed on site within the lower (west) portion of the former Bridger View trailer park. No grading of this placed material is assumed.
2. The extent of debris removal (asphalt and concrete pieces) along the right (northern) streambank is limited to 35 percent of the existing bank length proposed for floodplain re-grading. The removal of debris would extend 6 feet into the bank and have a vertical height of 6 feet from bank toe to upper limits.
3. Existing mature trees (diameter at breast height (dbh) > 10 in.) along right bank would be left in place (along with any debris material that is functioning to support the tree). Gap areas between mature trees (identified on drawings) would be graded to facilitate floodplain access.
4. Existing floodplain/wetland area on right bank would be used to control and filter right overbank return flows to the main channel.
5. Dedicated pedestrian access to the East Gallatin River would occur at two locations within the North Parcel.

South Parcel Assumptions

1. Excavated material generated from floodplain/wetland grading would be placed on site within the North Parcel—lower (west) portion of the former Bridger View trailer park. No grading of this placed material is assumed.
2. Excavated material generated from floodplain grading consists of existing surface vegetation and clean soil. Material does not contain large debris or hazardous materials.
3. The existing driveway into the South Parcel from Griffin Drive will be maintained up to the point where it begins to curve to the east.
4. Existing large trees within the farmstead area would be retained.
5. The existing pond will be filled and re-graded; existing berms along both sides of the pond would be re-graded and used for fill material and planted with riparian vegetation.
6. There will be no dedicated pedestrian access to the East Gallatin River or Bozeman Creek from within the South Parcel.
7. Clean-up of debris along the river corridor will only occur along the left streambank (East Gallatin River).
8. Existing gravel base material surrounding the farmstead buildings and extending up the driveway to where it would be terminated from Griffin Drive would be removed to a depth of 1 foot, and the resulting area would be revegetated with upland vegetation.

9. The water-quality floodplain slough/swale feature included for Bozeman Creek is based on the following assumptions:
 - Excavation of swale will not extend deeper than the adjacent Bozeman Creek channel invert. This would minimize the potential for the slough feature to act as a drain to the adjacent Bozeman Creek channel.
 - A maximum of 2 percent of the total flow in Bozeman Creek would flow into the floodplain swale at the 2-year flood event.
 - The outfall of the slough back into Bozeman Creek would be adequately protected with vegetation and/or geotextiles to prevent erosion and headcutting up the slough.

Triangle Parcel Assumptions

1. Excavated material generated from floodplain grading would be placed on-site within the North Parcel—lower (west) portion of the former Bridger View trailer park. No grading of this placed material is assumed.
2. Excavated material generated from floodplain grading consists of existing surface vegetation and clean soil. Material does not contain large debris or hazardous materials.
3. Dedicated pedestrian access to the East Gallatin River will occur at a single location within the Triangle Parcel.
4. The existing car garage, bridge, and slaughterhouse buildings would be removed.
5. The driveway into the parcel from Story Mill Road would be truncated at the existing house (green roof).

Alternative 2—Ecological Restoration II

North Parcel Assumptions

- Excavated material generated from floodplain grading would be placed on site within the lower (west) portion of the former Bridger View trailer park. No grading of this placed material is assumed.
- The extent of debris removal (asphalt and concrete pieces) along the right (northern) streambank is limited to 35 percent of the existing bank length proposed for floodplain re-grading. Removal of debris would extend 6 feet into the bank and have a vertical height of 6 feet' from bank toe to upper limits.
- Existing mature trees (dbh > 10 inches) along right bank would be left in place (along with any debris material that is functioning to support the tree). Gap areas between mature trees (identified on drawings) would be graded to facilitate floodplain access.
- Existing floodplain/wetland area on the right bank would be used to control and filter right overbank return flows to the main channel.

- Dedicated pedestrian access to the East Gallatin River will occur at two locations within the North Parcel.

South Parcel Assumptions

1. Excavated material generated from floodplain/wetland grading would be placed on site within the North Parcel—lower (west) portion of the former Bridger View trailer park. No grading of this placed material is assumed.
2. Excavated material generated from floodplain grading consists of existing surface vegetation and clean soil. Material does not contain large debris or hazardous materials.
3. The existing driveway into the South Parcel from Griffin Drive will be maintained up to the point where it begins to curve to the east.
4. Existing large trees within the farmstead area would be retained.
5. The existing pond will be filled and re-graded; the existing berm along the west side of the pond would be re-graded and used for fill material, and the existing berm along the east side of the pond would not be re-graded and would be planted with riparian vegetation.
6. There will be no dedicated pedestrian access to the East Gallatin River from within the South Parcel.
7. No clean-up of debris along the river corridor (East Gallatin River) would occur.
8. The area surrounding the farmstead buildings would be planted with upland seeding.

Triangle Parcel Assumptions

1. Excavated material generated from floodplain grading would be placed on site within the North Parcel—lower (west) portion of the former Bridger View trailer park. No grading of this placed material is assumed.
2. Excavated material generated from floodplain grading consists of existing surface vegetation and clean soil. Material does not contain large debris or hazardous materials.
3. Dedicated pedestrian access to the East Gallatin River will occur at a single location within the Triangle Parcel.
4. The existing car garage would be removed.
5. The driveway into the parcel from Story Mill Road would be truncated at the existing house (green roof).

Alternative 3—Passive Restoration

North Parcel Assumptions

1. Dedicated pedestrian access to the East Gallatin River would occur at two locations within the North Parcel.

South Parcel Assumptions

1. Excavated material generated from re-grading would be placed on-site within the North Parcel—lower (west) portion of the former Bridger View trailer park. No grading of this placed material is assumed.
2. The existing driveway into the South Parcel from Griffin Drive will be maintained up to the point where it begins to curve to the east.
3. There will be no dedicated pedestrian access to the East Gallatin River from within the South Parcel.
4. Existing large trees within the farmstead area would be retained.
5. No clean-up of debris along the river corridor (East Gallatin River) would occur.
6. Existing gravel base material surrounding the farmstead buildings and extending up the driveway to where it would be terminated from Griffin Drive would be removed to a depth of 1 foot and the resulting area would be revegetated with upland vegetation.

Triangle Parcel Assumptions

1. Excavated material generated from floodplain grading would be placed on site within the North Parcel—lower (west) portion of the former Bridger View trailer park. No grading of this placed material is assumed.
2. Excavated material generated from floodplain grading consists of existing surface vegetation and clean soil. Material does not contain large debris or hazardous materials.
3. Dedicated pedestrian access to the East Gallatin River would occur at a single location within the Triangle Parcel.
4. The existing car garage would be removed.

APPENDIX D

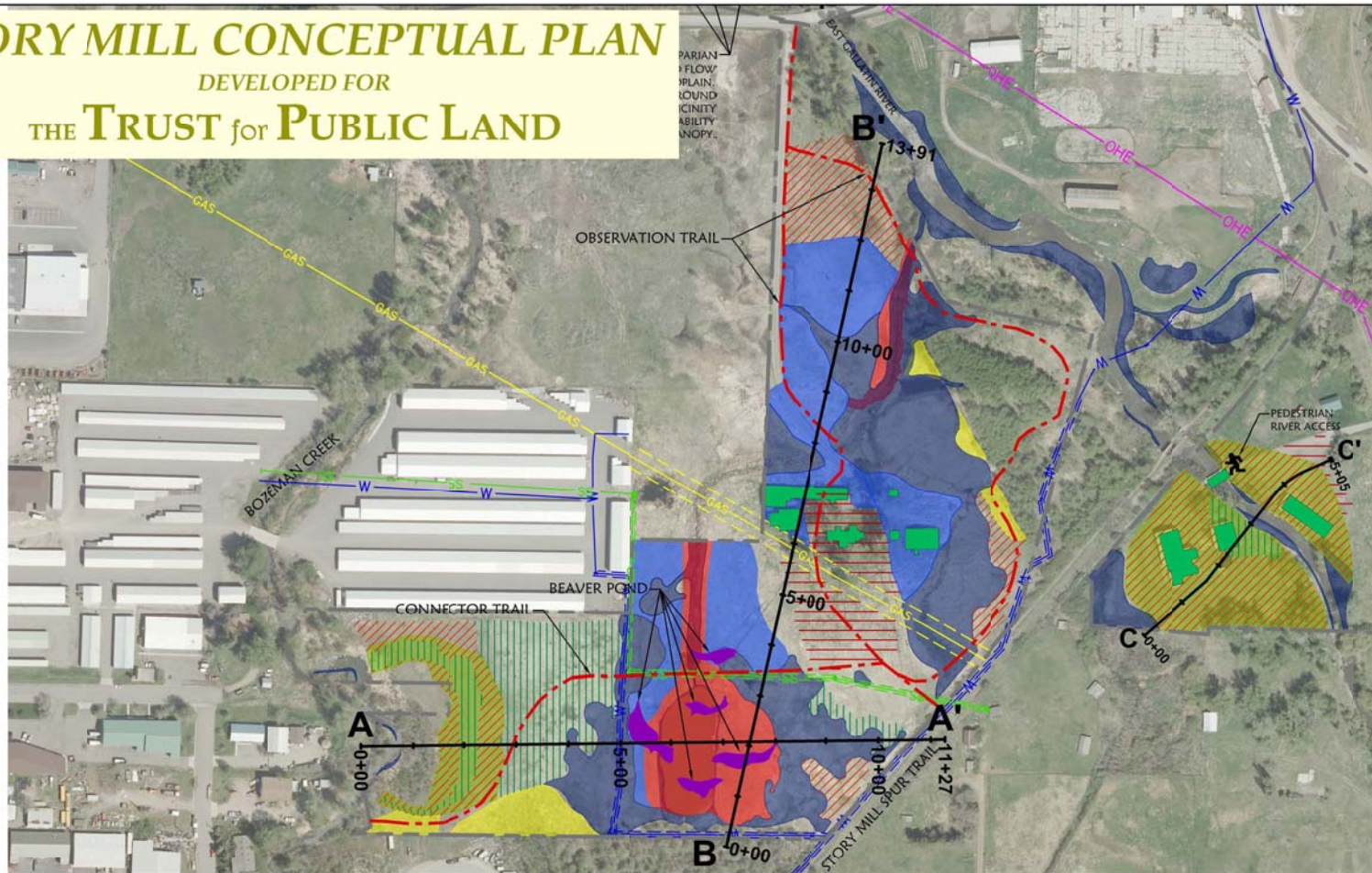
CONCEPTUAL RESTORATION DESIGN ALTERNATIVE FIGURES

Table D-1. Story Mill Conceptual Design Legend Supplement (September 12, 2013)

Legend Item	Description
Overhead electric	Overhead electric powerline. A 5-foot buffer around the pole was used as a no disturb zone. From that point outward, a 5:1 slope was used to bring that elevation down to surround the new floodplain elevation. Altogether, this resulted in a 25-foot buffer area around the power poles.
Gas (40-foot buffer)	Natural gas pipeline. A 20-foot buffer was applied to either side of this pipeline to ensure no impacts would occur.
Sanitary sewer (10-foot buffer)	Sanitary sewer pipeline. A 5-foot buffer was applied to either side of this pipeline to ensure no impacts would occur.
Water (10-foot buffer)	Water pipeline. A 5-foot buffer was applied to either side of this pipeline to ensure no impacts would occur.
Approximate property line	Approximate property line of the parcels owned by The Trust for Public Land.
Existing wetland	Wetland polygons were delineated by River Design Group Inc. in 2012.
Conceptual Trail	The conceptual trail feature has two components, a wetland observation trail and a connector trail. Both are at grade in upland and riparian areas and on 4-foot-wide, pressed wood boardwalk where it crosses wetlands. For costing purposes it is assumed that the boardwalk would be built by the Montana Conservation Corps or by volunteers.
Conceptual wetland	The area predicted to meet the jurisdictional requirements of a wetland following restoration actions. The polygons indicated as willow cuttings are also expected to meet the jurisdictional definition of a wetland.
Conceptual floodplain	The area that would be excavated to recreate floodplain areas. The willow cutting polygons within these new floodplains represent the predicted extent of flooding during the 2-year flood event. The surface of the floodplain and perimeter will be made to be more natural in the final design (if selected). For conceptual design and costing purposes we assumed a 1% continuous gradient along the floor of the floodplain polygon from the edge of the stream to the outer extent of the polygons.
Conceptual ditch grading	These polygons represent the areas that would be filled and re-graded to raise groundwater elevations. These newly re-graded areas would be seeded with a native wetland seed mix.
Building/Structure removal	Buildings and their foundations would be completely removed. The bridge on the Triangle Parcel is included in this category.
Willow cuttings	Areas that would be planted with willow cuttings are expected to meet jurisdictional wetland requirements over time. Cuttings would be planted in patches.
Riparian vegetation	Areas that would be drill seeded with a native riparian seed mix. Containerized plantings are not currently proposed because of the need to provide irrigation for one or two years following installation. However, we do have a list of proposed plantings if these are desired.
Upland vegetation	Areas would be drill seeded with a native upland seed mix. Containerized plantings are not currently proposed because of the need to provide irrigation for 1 or 2 years after installation. However, we do have a list of proposed plantings if these are desired. For the upland seeding areas on the Triangle Parcel (particularly Alternatives 2 and 3), excavating the gravel parking lots to a depth of 1 foot, and replacing 1foot of topsoil prior to seeding with native upland species are envisioned.
Natural revegetation	Areas that are currently revegetating and do not require active restoration efforts.

STORY MILL CONCEPTUAL PLAN

DEVELOPED FOR
THE TRUST for PUBLIC LAND



NOTES: LEGEND

UTILITIES:

- OVERHEAD ELECTRIC
- GAS (40' BUFFER)
- SANITARY SEWER (10' BUFFER)
- WATER (10' BUFFER)

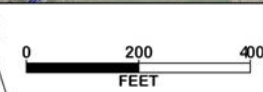
APPROXIMATE PROPERTY LINE

- EXISTING WETLAND
- CONCEPTUAL TRAIL
- CONCEPTUAL WETLAND
- CONCEPTUAL FLOODPLAIN
- CONCEPTUAL DITCH GRADING

BUILDING/STRUCTURE REMOVAL

- CONCEPTUAL VEGETATION PLAN
- WILLOW CUTTINGS
- RIPIARIAN VEGETATION
- UPLAND VEGETATION
- NATURAL REVEGETATION

N



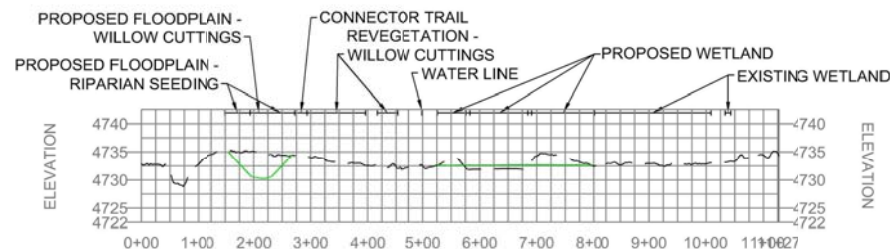
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ALTERNATIVE 1 SOUTH PARCEL CONCEPTUAL PLAN

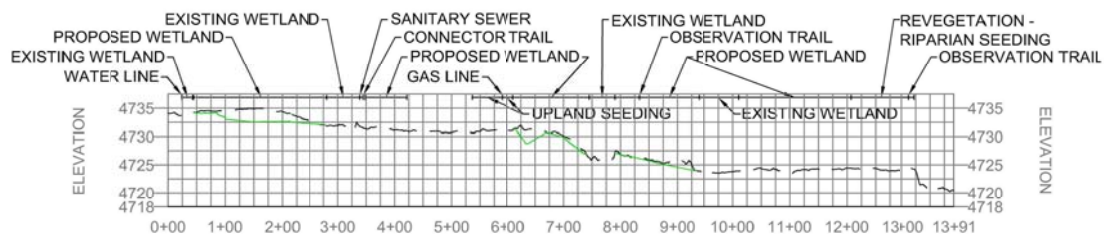
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CH: MR	SCALE:	RSI DWG NO.	
AP: RM			

STORY MILL CONCEPTUAL PLAN

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A - A'



— PROPOSED GROUND
— EXISTING GROUND

B - B'

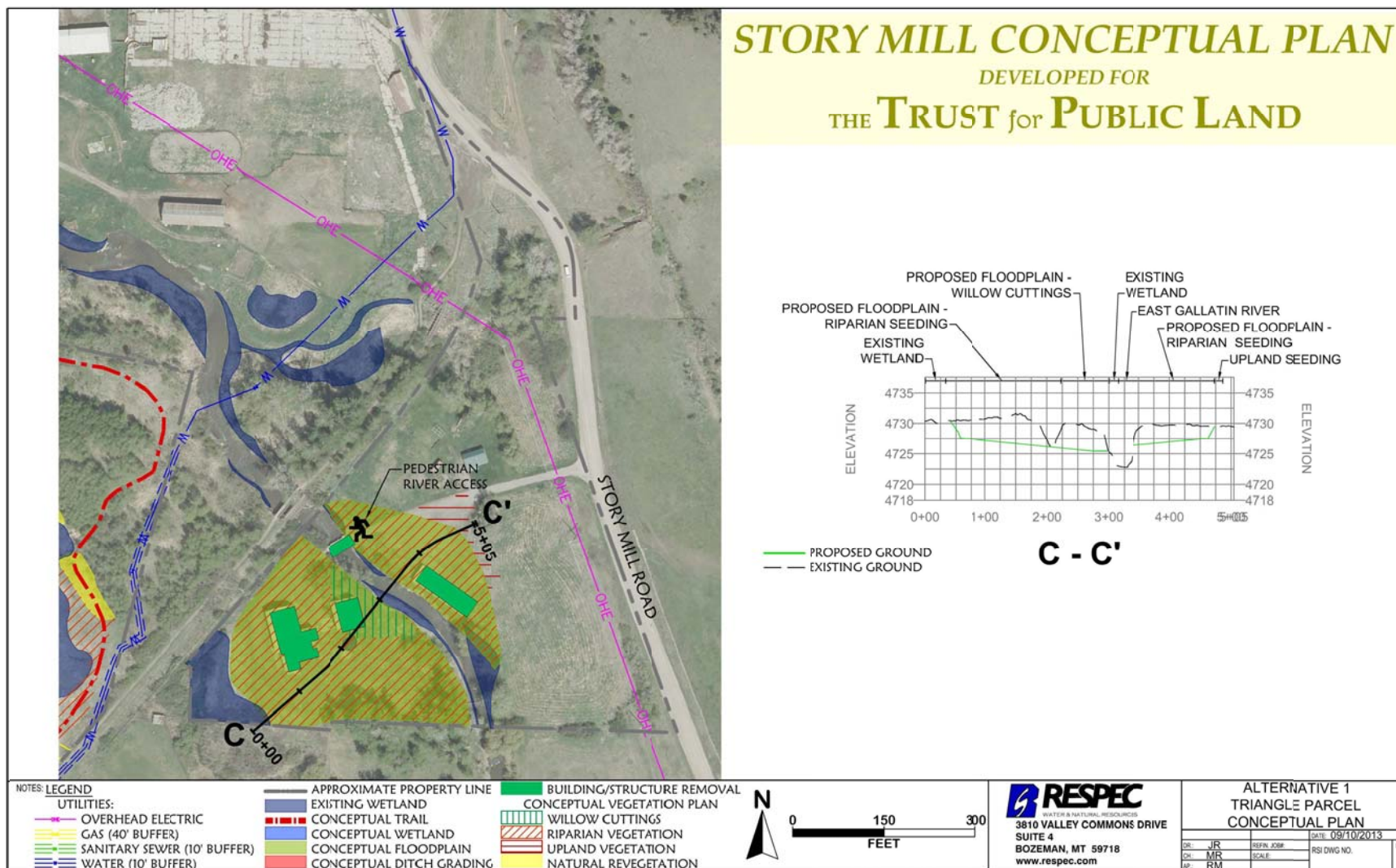
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VERTICAL EXAGGERATION: 10X

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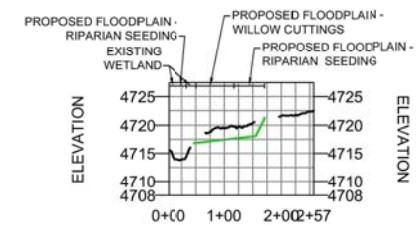
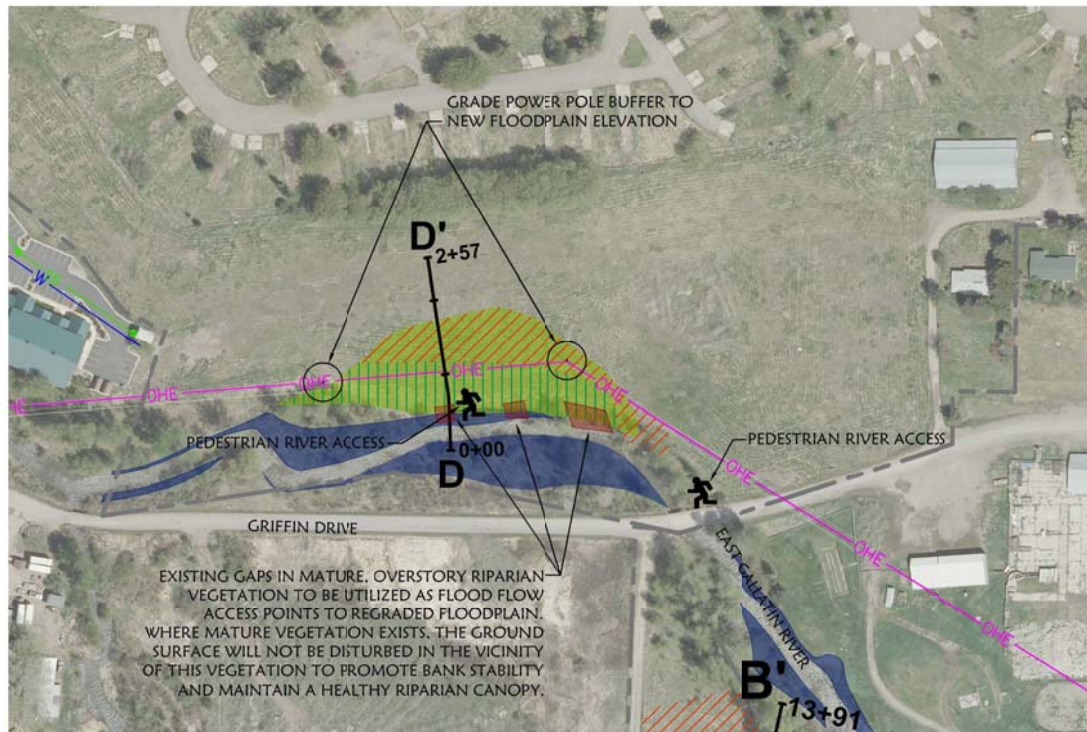
ALTERNATIVE 1
SOUTH PARCEL
CONCEPTUAL PROFILES

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CHECK: MR	RSI DWG NO.:
APP: RM	



STORY MILL CONCEPTUAL PLAN

DEVELOPED FOR
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— PROPOSED GROUND
— EXISTING GROUND

D - D'

NOTES: LEGEND

UTILITIES:

- OVERHEAD ELECTRIC
- GAS (40' BUFFER)
- SANITARY SEWER (10' BUFFER)
- WATER (10' BUFFER)

- APPROXIMATE PROPERTY LINE
- EXISTING WETLAND
- CONCEPTUAL TRAIL
- CONCEPTUAL WETLAND
- CONCEPTUAL FLOODPLAIN
- CONCEPTUAL DITCH GRADING

- BUILDING/STRUCTURE REMOVAL
- CONCEPTUAL VEGETATION PLAN
- WILLOW CUTTINGS
- RIPARIAN VEGETATION
- UPLAND VEGETATION
- NATURAL REVEGETATION



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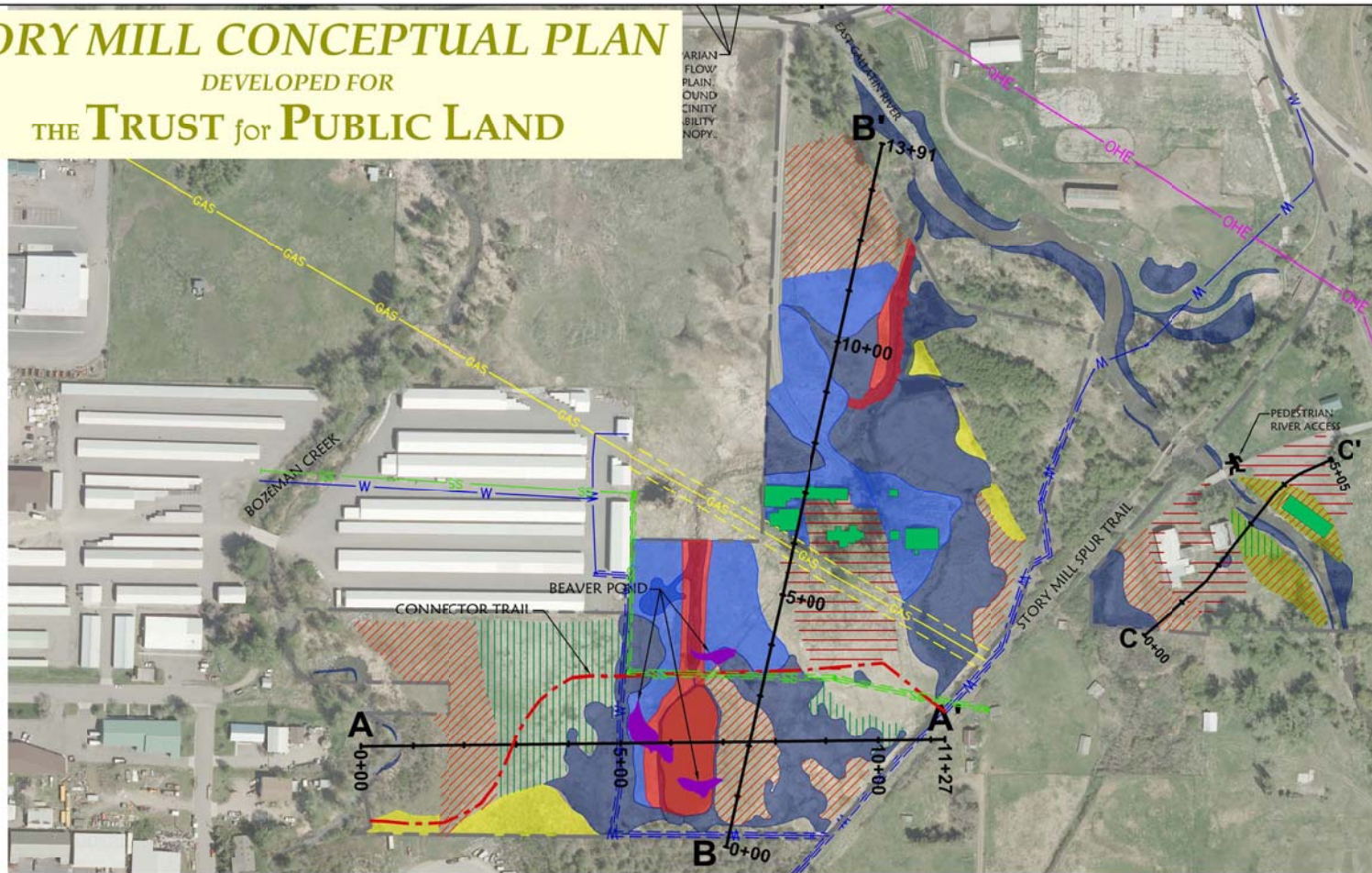
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ALTERNATE 2 NORTH PARCEL CONCEPTUAL PLAN

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STORY MILL CONCEPTUAL PLAN

DEVELOPED FOR
THE TRUST for PUBLIC LAND



NOTES: LEGEND

UTILITIES:

- OVERHEAD ELECTRIC
- GAS (40' BUFFER)
- SANITARY SEWER (10' BUFFER)
- WATER (10' BUFFER)

APPROXIMATE PROPERTY LINE

- EXISTING WETLAND
- CONCEPTUAL TRAIL
- CONCEPTUAL WETLAND
- CONCEPTUAL FLOODPLAIN
- CONCEPTUAL DITCH GRADING

BUILDING/STRUCTURE REMOVAL

- CONCEPTUAL VEGETATION PLAN
- WILLOW CUTTINGS
- RIPIARIAN VEGETATION
- UPLAND VEGETATION
- NATURAL REVEGETATION



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FEET

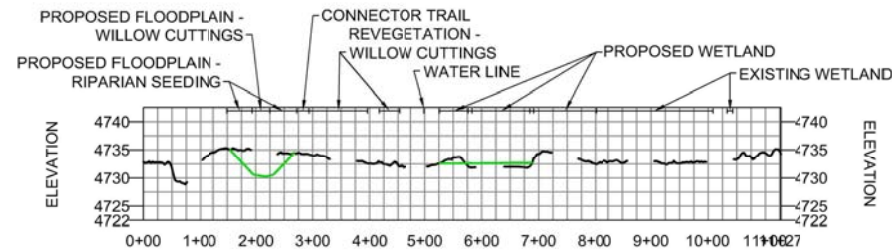
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ALTERNATIVE 2 SOUTH PARCEL CONCEPTUAL PLAN

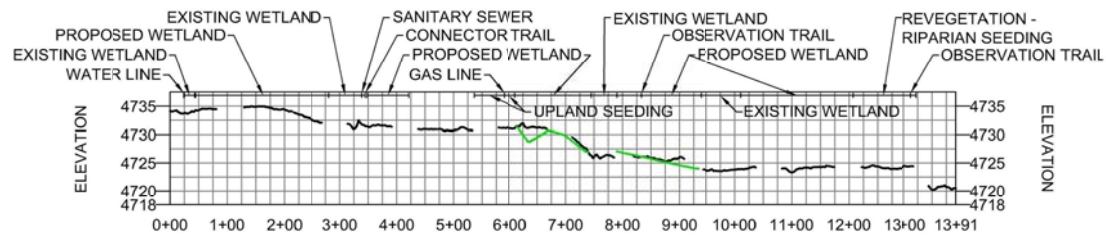
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CH: MR	SCALE:	RSI DWG NO.	
AP: RM			

STORY MILL CONCEPTUAL PLAN

DEVELOPED FOR
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A - A'



— PROPOSED GROUND
— EXISTING GROUND

B - B'

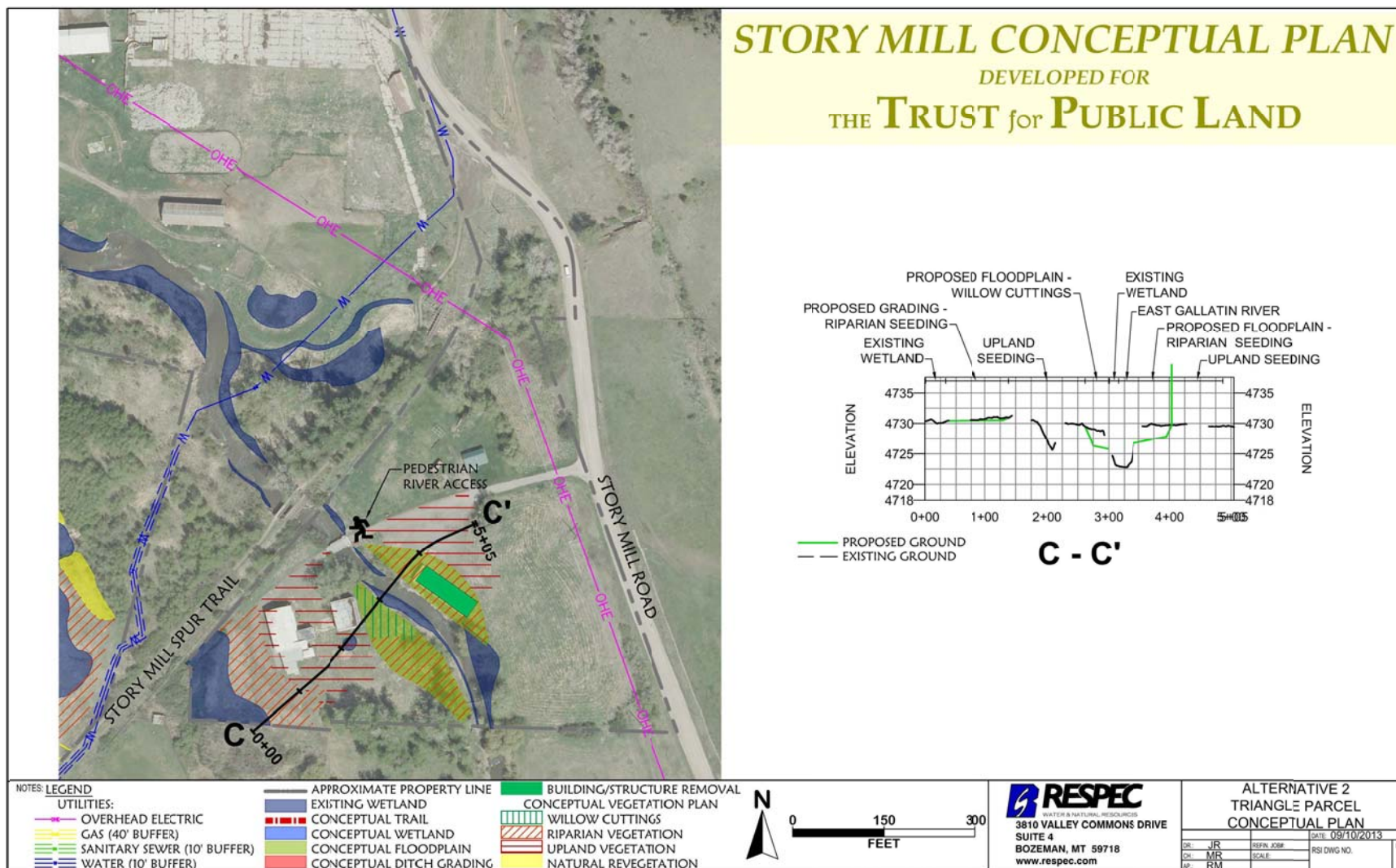
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FEET
VERTICAL EXAGGERATION: 10X

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ALTERNATIVE 2
SOUTH PARCEL
CONCEPTUAL PROFILES

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NOTES: LEGEND:

UTILITIES:	APPROXIMATE PROPERTY LINE	BUILDING/STRUCTURE REMOVAL
OVERHEAD ELECTRIC	EXISTING WETLAND	CONCEPTUAL VEGETATION PLAN
GAS (40' BUFFER)	CONCEPTUAL TRAIL	WILLOW CUTTINGS
SANITARY SEWER (10' BUFFER)	CONCEPTUAL WETLAND	RIPARIAN VEGETATION
WATER (10' BUFFER)	CONCEPTUAL FLOODPLAIN	UPLAND VEGETATION
	CONCEPTUAL DITCH GRADING	NATURAL REVEGETATION

0 150 300
FEET

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ALTERNATE 3
NORTH PARCEL
CONCEPTUAL PLAN

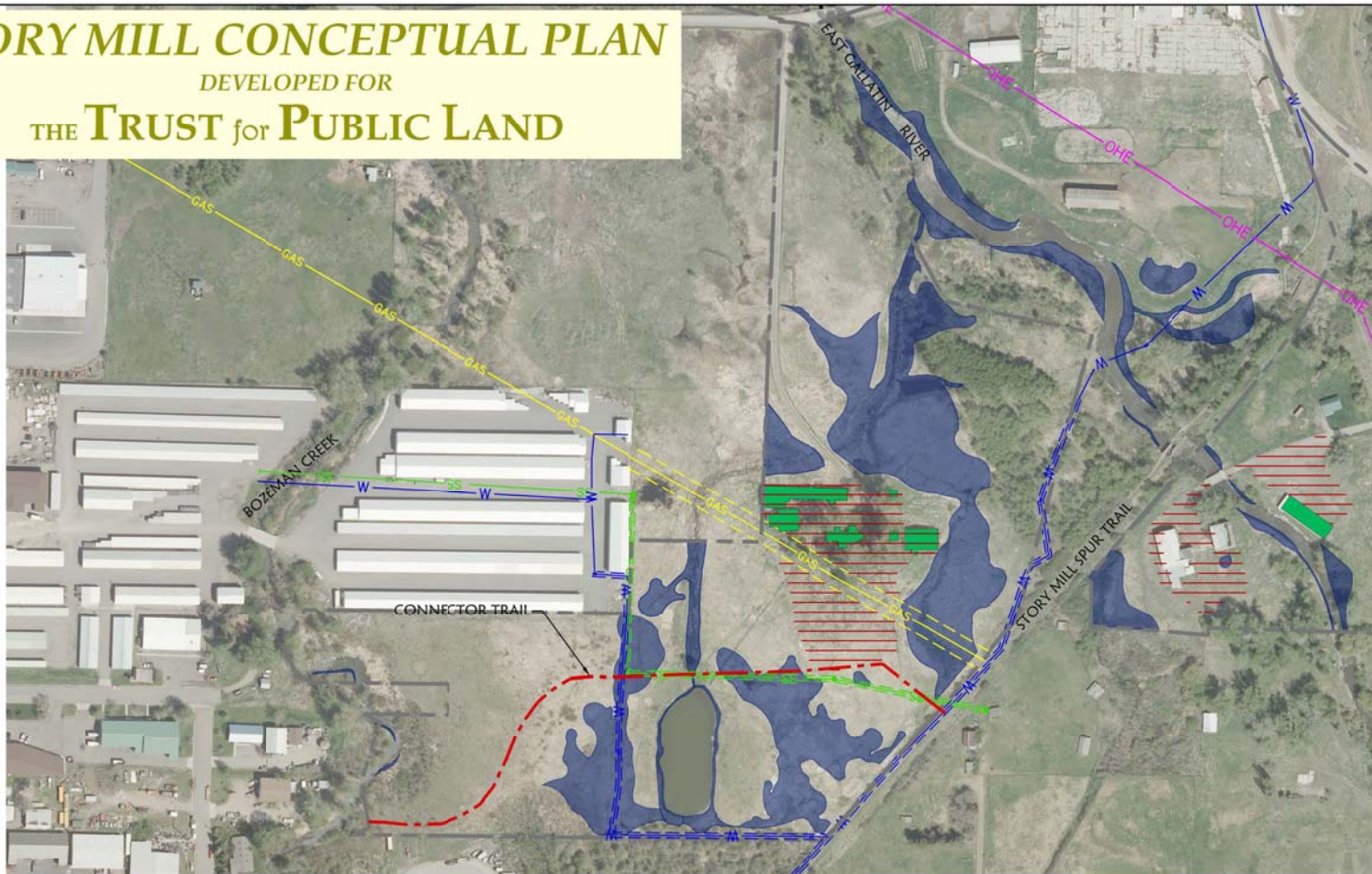
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RSI DWG NO.

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CHK: MR
APP: RM

REF: JWB
SCALE:

STORY MILL CONCEPTUAL PLAN

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NOTES: LEGEND

UTILITIES:

- OVERHEAD ELECTRIC
- GAS (40' BUFFER)
- SANITARY SEWER (10' BUFFER)
- WATER (10' BUFFER)

APPROXIMATE PROPERTY LINE

- EXISTING WETLAND
- CONCEPTUAL TRAIL
- CONCEPTUAL WETLAND
- CONCEPTUAL FLOODPLAIN
- CONCEPTUAL DITCH GRADING

BUILDING/STRUCTURE REMOVAL

- CONCEPTUAL VEGETATION PLAN
- WILLOW CUTTINGS
- RIPARIAN VEGETATION
- UPLAND VEGETATION
- NATURAL REVEGETATION



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ALTERNATIVE 3 SOUTH PARCEL CONCEPTUAL PLAN

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AP: RM			

STORY MILL CONCEPTUAL PLAN

DEVELOPED FOR
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NOTES:		LEGEND	
UTILITIES:		—	APPROXIMATE PROPERTY LINE
—	OVERHEAD ELECTRIC	—	EXISTING WETLAND
—	GAS (40' BUFFER)	—	CONCEPTUAL TRAIL
—	SANITARY SEWER (10' BUFFER)	—	CONCEPTUAL WETLAND
—	WATER (10' BUFFER)	—	CONCEPTUAL FLOODPLAIN
		—	CONCEPTUAL DITCH GRADING
		—	BUILDING/STRUCTURE REMOVAL
		—	CONCEPTUAL VEGETATION PLAN
		—	WILLOW CUTTINGS
		—	RIPARIAN VEGETATION
		—	UPLAND VEGETATION
		—	NATURAL REVEGETATION



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ALTERNATIVE 3 TRIANGLE PARCEL CONCEPTUAL PLAN

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APPENDIX E

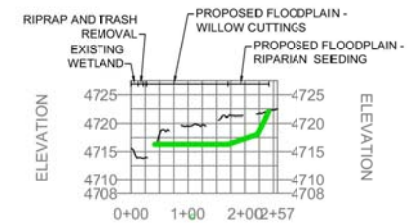
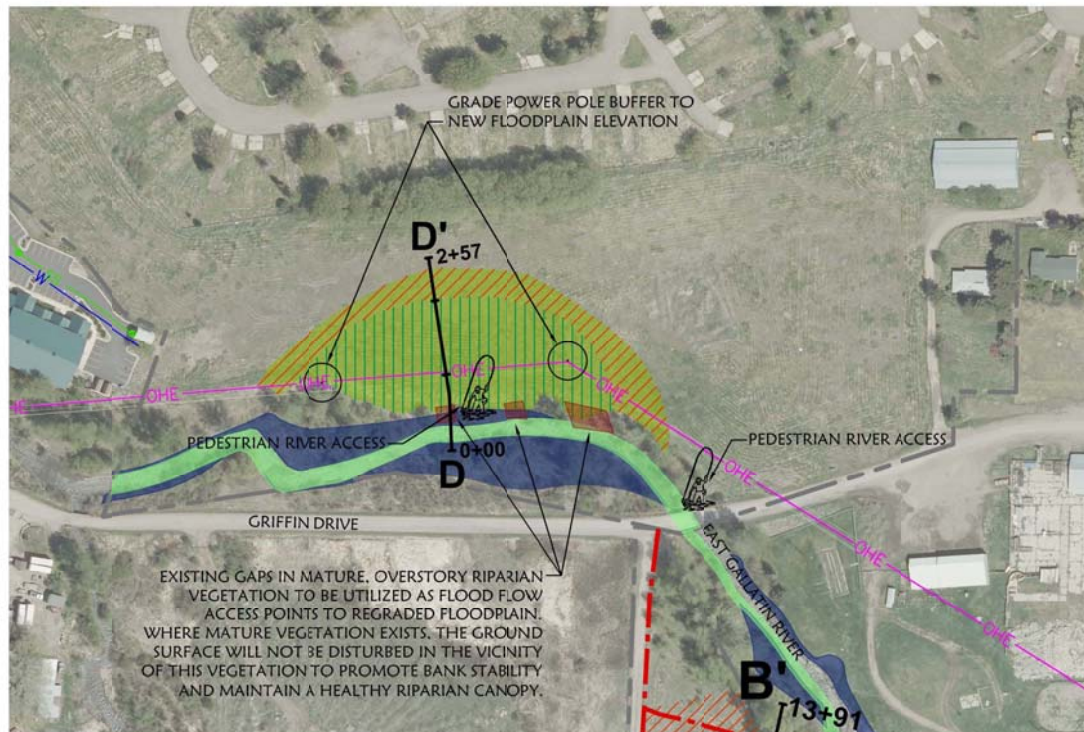
**CONCEPTUAL RESTORATION DESIGN SELECTED ALTERNATIVE
FIGURES**

Table E-1. Story Mill Conceptual Design Legend Supplement

Legend Item	Description
Overhead electric	Overhead electric power line. A 5-foot buffer around the pole was used as a no disturb zone. From that point outward, a 5:1 slope was used to bring that elevation down to surround the pole at the new floodplain elevation. Altogether, this resulted in a 25-foot buffer area around the power poles.
Gas (50-foot buffer)	Natural gas pipeline. A 25-foot buffer was applied to either side of this pipeline to ensure no impacts would occur.
Sanitary sewer (10-foot buffer)	Sanitary sewer pipeline. A 5-foot buffer was applied to either side of this pipeline to ensure no impacts would occur.
Water (10-foot buffer)	Water pipeline. A 5-foot buffer was applied to either side of this pipeline to ensure no impacts would occur.
Approximate property line	Approximate property line of the parcels owned by The Trust for Public Land.
Existing wetland	Wetland polygons were delineated by River Design Group Inc. in 2012.
Conceptual Trail	The conceptual trail feature has two components, a wetland observation trail and a connector trail. Both are at grade in upland and riparian areas and on 4-foot-wide, pressed wood boardwalk where it crosses wetlands. For costing purposes it is assumed that the boardwalk would be built by the Montana Conservation Corps or by volunteers.
Conceptual wetland	The area predicted to meet the jurisdictional requirements of a wetland following restoration actions. The polygons indicated as willow cuttings are also expected to meet the jurisdictional definition of a wetland.
Conceptual floodplain	The area that would be excavated to recreate floodplain areas. The willow cutting polygons within these new floodplains represent the predicted extent of flooding during the 2-year flood event. The surface of the floodplain and perimeter will be made to be more natural in the final design (if selected). For conceptual design and costing purposes we assumed a 1% continuous gradient along the floor of the floodplain polygon from the edge of the stream to the outer extent of the polygons.
Conceptual ditch grading	These polygons represent the areas that would be filled and re-graded to raise groundwater elevations. These newly re-graded areas would be seeded with a native wetland seed mix.
Building/Structure removal	Buildings and their foundations would be completely removed.
Willow cuttings	Areas that would be planted with willow cuttings are expected to meet jurisdictional wetland requirements over time. Cuttings would be planted in patches.
Riparian vegetation	Areas that would be drill seeded with a native riparian seed mix. Containerized plantings are not currently proposed because of the need to provide irrigation for one or two years following installation.
Upland vegetation	Areas would be drill seeded with a native upland seed mix. Containerized plantings are not currently proposed because of the need to provide irrigation for 1 or 2 years after installation. For the upland seeding areas on the Triangle Parcel, excavating the gravel parking lots to a depth of 1 foot, and replacing 1-foot of topsoil prior to seeding with native upland species are envisioned.
Natural revegetation	Areas that are currently revegetating and do not require active restoration efforts.
Naturalized pond	The existing pond would be reconfigured and planted with willows. Configuration is based on the original design by River Design Group.

STORY MILL CONCEPTUAL PLAN

DEVELOPED FOR
THE TRUST for PUBLIC LAND



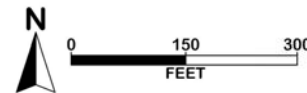
D - D'

— PROPOSED GROUND
- - - EXISTING GROUND

NOTES: LEGEND
UTILITIES:
OVERHEAD ELECTRIC
GAS (50' BUFFER)
SANITARY SEWER (10' BUFFER)
WATER (10' BUFFER)
APPROXIMATE PROPERTY LINE

EXISTING WETLAND
CONCEPTUAL TRAIL
CONCEPTUAL WETLAND
CONCEPTUAL FLOODPLAIN
CONCEPTUAL EXCAVATION/DITCH GRADING
RIPRAP AND TRASH REMOVAL

BUILDING/STRUCTURE REMOVAL
CONCEPTUAL VEGETATION PLAN
WILLOW CUTTINGS
RIPARIAN VEGETATION
UPLAND VEGETATION
NATURAL REVEGETATION



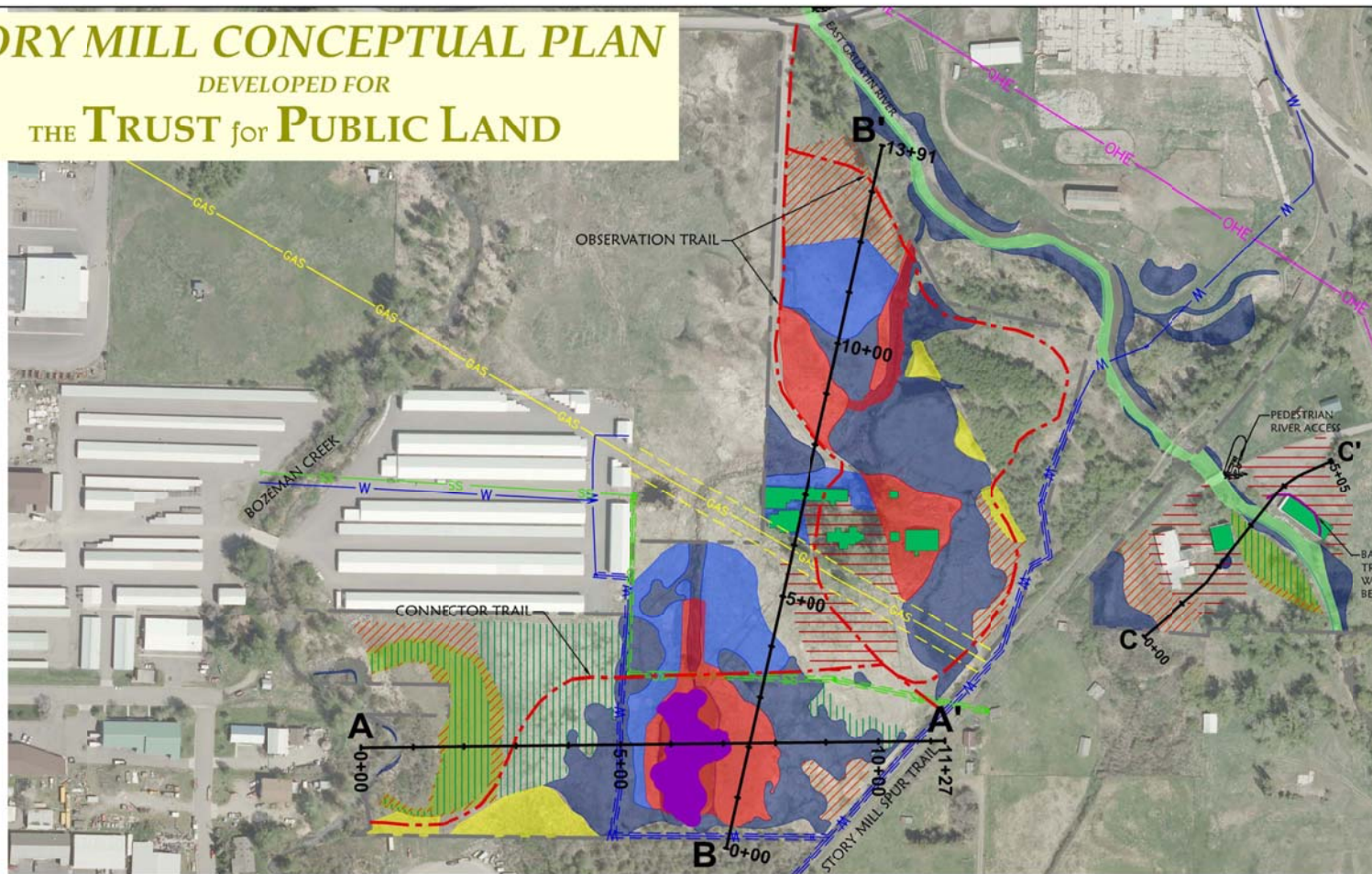
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SELECTED ALTERNATIVE
NORTH PARCEL
CONCEPTUAL PLAN

DR: JR	REP. JOB#	DATE: 10/11/2013	REV
CH: MR	SCALE:	RSI DWG NO.	01
OP: RM			

STORY MILL CONCEPTUAL PLAN

DEVELOPED FOR
THE TRUST for PUBLIC LAND



NOTES: LEGEND
UTILITIES:
OVERHEAD ELECTRIC
GAS (50' BUFFER)
SANITARY SEWER (10' BUFFER)
WATER (10' BUFFER)
APPROXIMATE PROPERTY LINE

EXISTING WETLAND
CONCEPTUAL TRAIL
CONCEPTUAL WETLAND
CONCEPTUAL FLOODPLAIN
CONCEPTUAL EXCAVATION/DITCH GRADING
NATURALIZED POND
RIPRAP AND TRASH REMOVAL

BUILDING/STRUCTURE REMOVAL
CONCEPTUAL VEGETATION PLAN
WILLOW CUTTINGS
RIPARIAN VEGETATION
UPLAND VEGETATION
NATURAL REVEGETATION



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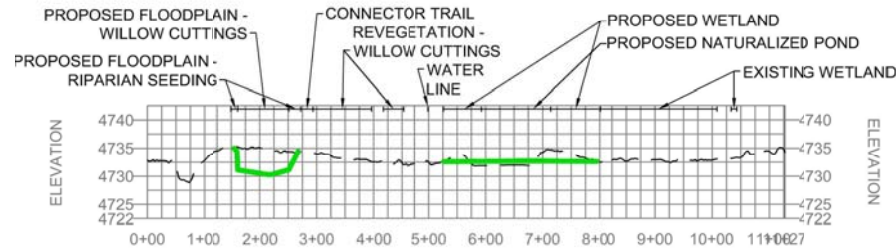
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SELECTED ALTERNATIVE
SOUTH PARCEL
CONCEPTUAL PLAN

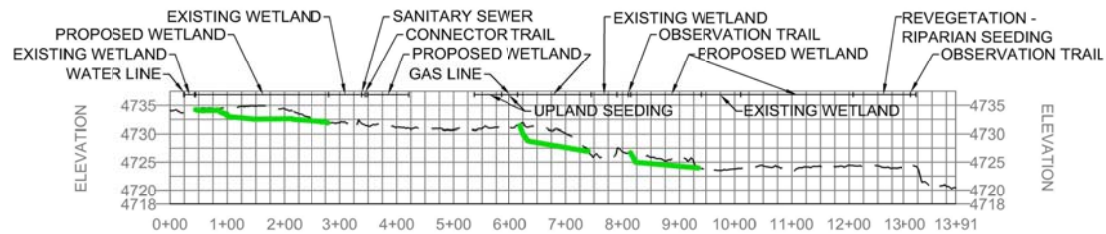
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CHK: MR	SCALE:	RSI DWG NO.	01
APP: RM			

STORY MILL CONCEPTUAL PLAN

DEVELOPED FOR
THE TRUST for PUBLIC LAND



A - A'



B - B'

— PROPOSED GROUND
— EXISTING GROUND

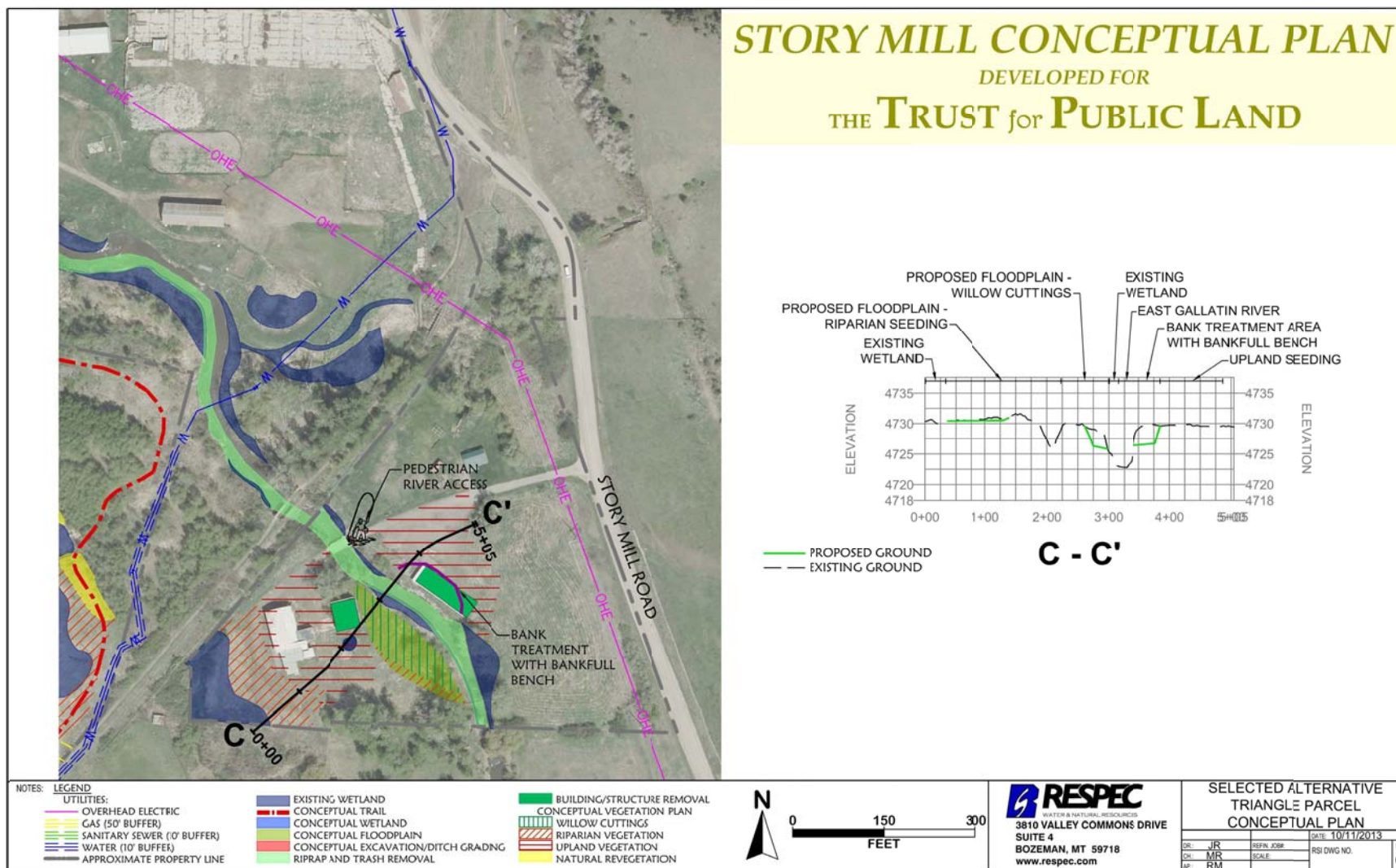
NOTES:

0 200 400
FEET
VERTICAL EXAGGERATION: 10X

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SELECTED ALTERNATIVE
SOUTH PARCEL
CONCEPTUAL PROFILES

DATE: 10/11/2013	REV: 01
DESIGN: JR	REFIN. JOB: SCALE
CHECK: MR	RSI DWG NO.
APP: RM	



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